The FOUNDRY

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Makes Difficult Castings

Young Foundryman Has Built Up an Organization of Highly Skilled Operators Who Handle Classes of Castings Usually Considered of a Hazardous Character—Makes Diesel Engine Castings

AMONG the biographical sketches available for the emulation of American youth, those of foundrymen are not the most numerous or spectacular. Even those who are listed, in many cases began industrial life as boys in some other line and later drifted into the foundry business, either through accident or through a chain of circumstances for which they were not directly responsible. A relatively small number began as foundry molder apprentices and out of this number a relatively still smaller number deliberately chose a foundry career for themselves and entered the foundry from actual choice. In the majority of cases the boy entered the foundry because he learned of an opening there at about the time he found himself obliged to become, at least in some measure, self supporting. He remained there, not because the work and environment appealed to him, but because he objected to the idea of starting at anything else after he had been there for some time and in accordance with the almost universal human belief that it is better to live with the devil you know than it is with the devil you don't know.

The foundry never has had the same surface appeal to boys as that presented by the machine and pattern shop. The

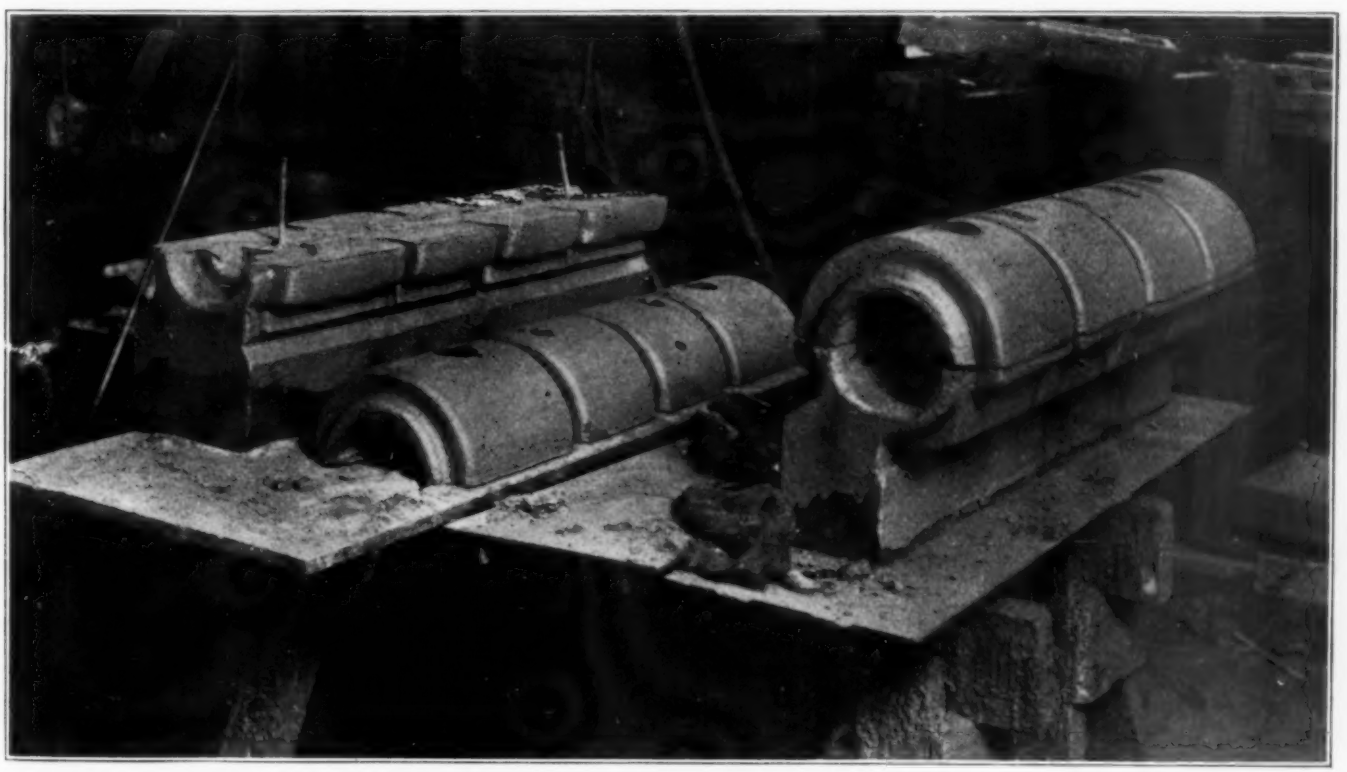


FIG. 1—PRINTING PRESS ROLLER CORES ARE MADE IN TWO PARTS, AFTERWARD PASTED, BOLTED TOGETHER AND SUSPENDED FROM THE COPE BY THE RECTANGULAR PRINT

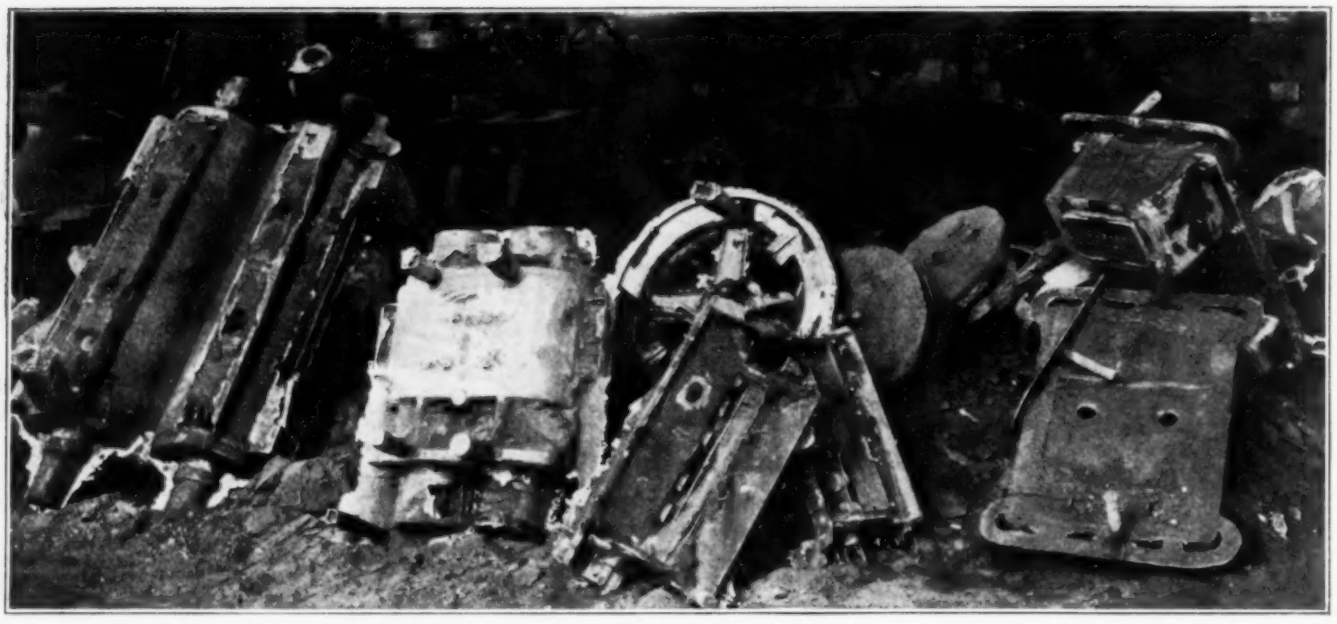


FIG. 2—GROUP OF TYPICAL CASTINGS INCLUDING COLOR PRESS ROLLERS, OIL AND GAS ENGINE CYLINDERS, VARIOUS TYPES OF WHEELS AND MOTOR BASES

average boy does not look beneath the surface, nor trouble his head much about the future and if given a free choice he selects the job that seems to require the least effort and at which he can maintain a more respectable appearance. It is a notorious fact, especially in recent years, that foundries have had to do without apprentices, while the machine shops and pattern shops in the same plants have from one to fifty boys on their waiting lists. Consideration of the foregoing lends a certain interest to the career of Frank J. Opatrny, secretary and general manager of the Cuyahoga Foundry Co., Cleveland.

While still under 30 years of age he has arrived at a goal to which he has been constantly aiming since before he left school. Against the advice of acquaintances, friends and even that of his father, who had worked as a journeyman molder for many years and who had planned what he considered a more interesting and lucrative career for his son, he deliberatly entered a foundry after completing a regular high school course in East Technical high school. The curriculum included a course in foundry practice which appealed so strongly to the young man that he decided to follow it through as he would have done if he had elected to take up any other profession.

He served a regular apprenticeship in one of the leading heavy work jobbing foundries in the city, followed by two years in the pattern shop of another plant and two years as a journeyman molder in several foundries and in addition had taken a business course at night school, and then considering that

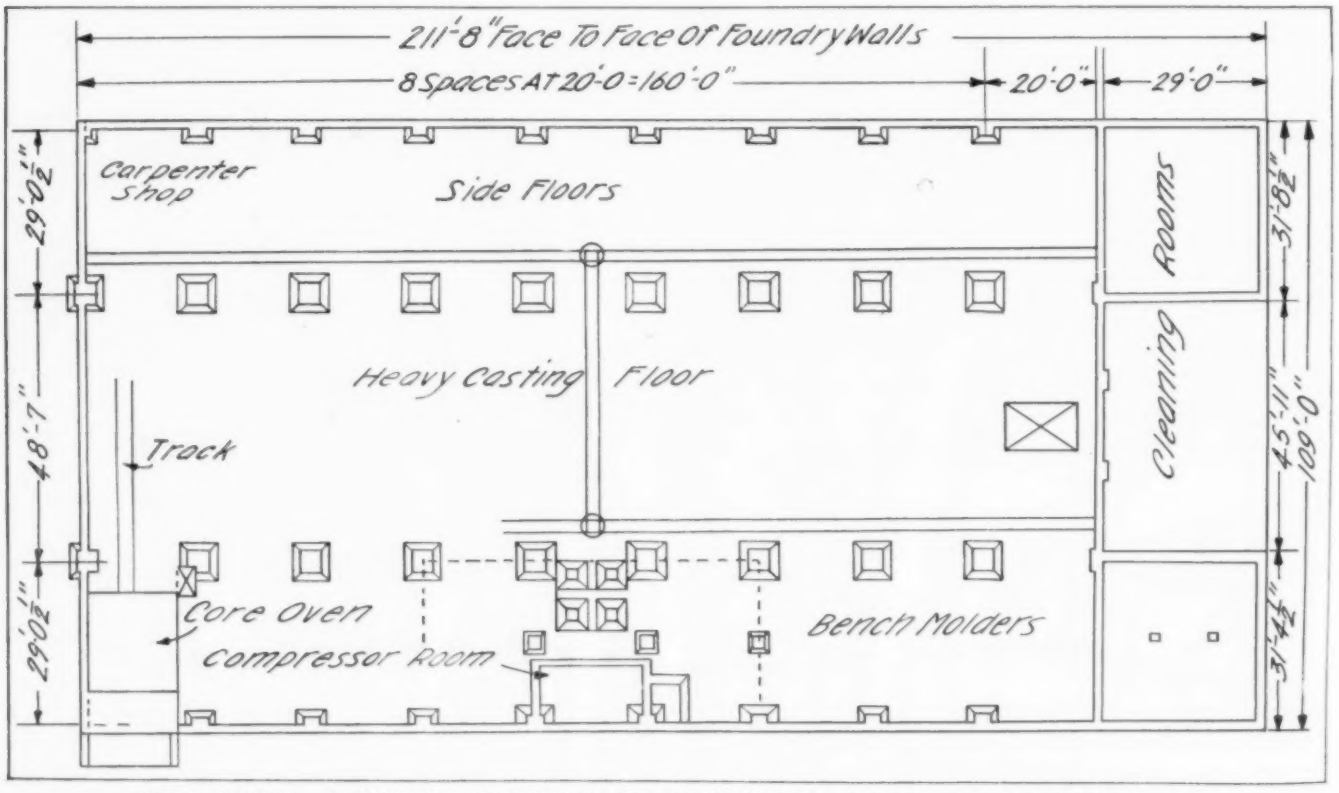


FIG. 3—GENERAL LAYOUT OF FOUNDRY FLOOR SHOWING LOCATION OF THE DIFFERENT UNITS

he had completed a post graduate course he decided to open a foundry of his own. He organized a company in 1920 which secured a tract of land close to the Belt line of the New York Central railroad, on the outskirts of the city where it joins the village of Cuyahoga Heights, and in January 1921 the foundry was up and in operation. He made the layout, designed the building and personally supervised its construction which was done by day labor.

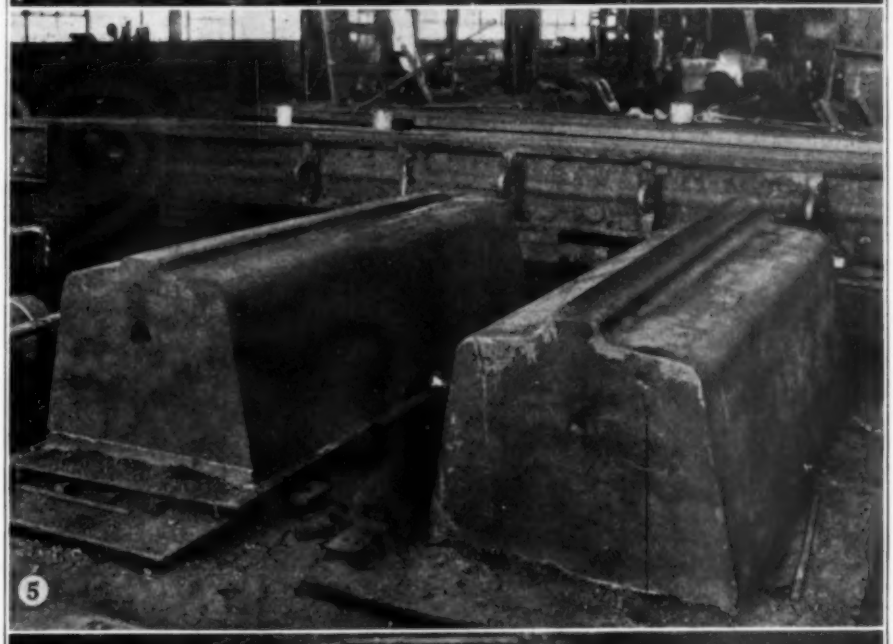
Instead of shopping around among prospective customers with a view of securing orders for plain castings, involving a minimum of skill on the part of the workman, and requiring only a mediocre grade of iron, he decided to capitalize his practical foundry knowledge by soliciting orders for high grade castings—those that usually are classed as hazardous, in that they call for the services of expert molders and in addition must conform to rigid specifications. Typical examples are ammonia cylinders and fittings, compressor castings, printing press rollers, lamp work castings, diesel engine castings, etc. The castings are made in green-sand molds, skin-dried molds in which the face of the mold is dried either by charcoal baskets or by oil torch, and in dry-sand molds in which the entire mold is dried in the oven. Circumstances and an intimate knowledge of the requirements of each casting are the governing factors in the selection of the type of mold to employ.

Shop Layout

The shop is built on a deposit of natural sand of excellent quality for medium and heavy work. Sand dug while preparing to put down the foundations has been piled outside one end of the foundry and serves as a source of supply when new sand is required either for facing sand or core mixtures. When that supply becomes exhausted a practically unlimited quantity may be secured by sinking a pit at almost any point in the yard. The property slopes away from the back end of the foundry and furnishes an ideal dumping ground for slag, ashes, burnt sand and all other kinds of rubbish incident to foundry operations.

Coke and iron are unloaded close to a narrow gage track extending close to and along one side of the building. A turntable at one point connects it with a short spur leading on the cupola elevator. The general layout of the building is shown in Fig. 3.

The building is of the steel frame, brick wall type characteristic of nearly



FIGS. 4 AND 5—THREE OF THE FOUR CORE SECTIONS REQUIRED TO FORM THE INSIDE OF THE MOLD SHOWN IN FIG. 6 FIG. 6—BOARDS SIMILAR TO THOSE SHOWN ARE PLACED ALL OVER THE BOTTOM TO SUPPORT THE CORES BEFORE THE COPE IS BOLTED ON TO THEM

all foundries erected in recent years in which the window sash occupies the greater part of the wall space. Swinging sections in every sash unit insures ventilation in addition to light. The monitor roof also provides light and further ventilation. The floor space is laid off in three main divisions by two rows of steel columns spaced on 20-foot centers. The center bay is 48 feet 7 inches wide and each of the side bays is 29 feet. The total length of the building is 211 feet 8 inches. A brick curtain wall extending the full height of the building at one end separates the foundry proper from the cleaning room, 29 feet wide and extending entirely across the building. The tumbling barrels and sand-blast installation are located in the upper left hand division as shown in the illustration. The large castings are chipped and cleaned in the center division which also serves as shipping room.

FIG. 7—PATTERN AND COPE FOR A DIESEL ENGINE LOWER HALF CRANKCASE—THE COPE IS DRIED IN THE OVEN TO BETTER RESIST THE *LIFT* OF THE CORES

Crane Service

One end of the side floor bay is fitted up as a carpenter shop for making and repairing wood flasks and other work of the character incident to a jobbing foundry. The remainder of the space is laid out in a number of floors extending from the wall to a gangway laid from end to end of the bay and close to the columns. A narrow gage track on the gangway, connected by a turntable to a branch extending across the central bay to the cupola, facilitates conveying the iron to the most distant floors. A buggy ladle is employed for this purpose. The castings made on this side of the shop range from 50 to 3000 pounds and are poured from double shank ladles filled from the buggy ladle, and occasionally, in the case of large castings, by use of the crane. A 5-ton crane has been provided for handling large molds and castings, and for carrying loads of castings to the cleaning room.

The western end of the center bay forms part of the core department. Many of the large cores are made on the floor and lifted on to the car which runs on a track extending into the oven. All the larger cores are used in molds made in the center bay and after they are dried they are lifted from the car and either taken directly to the molds or placed temporarily on the floor. Many of the cores are made in sections and these cores are assembled, pasted and blacked on the floor in the vicinity of the core car before they are taken to the waiting molds. Examples of both kinds are shown in Figs. 1 and 4. Fig. 5 shows two sections of a continuous core for the diesel engine crankcase frame, shown in Fig. 6, and the type of core used in printing press rollers for color work is shown in Fig. 1. The bay is spanned by a 10-ton crane built by the Cleveland Crane & Engineering Co., Wickliffe, O. This is of sufficient capacity to handle any of the castings made in the foundry. A second crane is in contemplation should business or operating conditions warrant the installation. The columns and superstructure are designed to carry a load in excess of that imposed by two cranes.

The coke-fired core oven 15 x 20 x 10 feet occupies the west end of the third bay as shown in Fig. 3. Two large cars with uprights for supporting detachable decks are provided for holding the large cores. Small cores are dried on tiers of long narrow shelves attached to the side walls of the oven. The firing chamber is on the outside at one end and the heat enters the oven through openings in the floor connecting with a long central flue. The work is so arranged that all the cores are made during the day and dried at night. The core room, approximately 60 feet long by 28 feet wide, extends from the core oven to the cupola room.

The cupola room proper occupies only the space between two columns and encloses the blower and compressor room, elevator and space back of the cupola. However, the charging floor of heavy steel plate, supported on substantial beams, extends the full width of the bay and occupies the space enclosed by four columns as shown by the dotted line in Fig. 3. One cupola, 84-inch shell, lined down to 60 inches, made by the Whiting Corp., Harvey, Ill., melts all the iron required, but provision has been made, both on the charging floor and on the foundation, for a second cupola which probably will be lined to 42 inches.

Cupola Room Kept Clean

An Ingersoll-Rand compressor driven by a 75-horsepower motor used for supplying air to the pneumatic tools and sand blast, is located in a room under the charging platform. This room also houses the Sturdevant fan used in connection with the cupola and which is driven by a 50 horsepower motor. The walls of the room are provided with windows that furnish ample light, and as a result no trouble is experienced in keeping the different pieces of machinery clean. In this respect the room offers a marked contrast to many cupola

rooms which often are dark and dirty.

The space between the cupola room and the cleaning room in the third bay is devoted to bench molding. None of the work is made in large quantities or on what usually is termed a production basis. Benches are provided at the end of the floors near the windows where the molds are made in snap flasks and afterwards laid down in rows on the floor. The molding practice involved presents no deviation from what is considered standard practice, with the single exception that instead of depending on matchplates to decide the position of the patterns and form the parting, each individual molder has to decide these points for himself and make his own parting. Occasionally an order is received that will warrant the making of a matchplate, but orders of that character are the exception and not the rule.

A representative example of some of the heavy castings made by the company is shown in Figs. 6 and 7, illustrating several stages in forming the mold for the lower half of a crankcase, or oil pan, for a 1000-horsepower diesel engine. The casting made in this mold is 23 feet long, 5 feet wide and 30 inches deep. The average metal thickness is about 1 inch, except on the bolt flanges where it is 2½ inches. Later approximately half an inch is planed off this face to form a joint on which the upper half of the crankcase is bolted. When in use, the lower half of the crankcase is filled with oil and therefore the casting, in addition to being straight and true to dimensions also must be oiltight. The outside of the mold is made in the floor and skin dried. The inside is formed with four sections of dry-sand core, butted together at the ends to form a continuous body, and suspended from the cope. One of the end sections is shown in Fig. 4, and two other sections are shown in Fig. 5.

Making the Mold

The mold is made in a pit provided with a bottom plate and anchor bolts that extend from the plate to the floor level. The pit will accommodate any pattern up to 10 x 30 feet, but in this instance it was only necessary to make an excavation approximately 7 x 25 feet and 4 feet deep. A cinder bed was spread over the bottom and a 3-inch pipe was placed upright in each corner leading from the cinder bed to above the floor level. Black sand was shoveled in on top of the cinders and rammed up to a point that would engage the bottoms of the ribs on the pattern. The crane was employed to lift the patterns by suitable turnbuckles hooked into substantial straps anchored firmly to interior ribs. It will be noted from the illustration shown in Fig. 7 that the box type pattern is constructed from 2-inch lumber to help in maintaining its shape and rigidity.

The pattern was lowered into the pit until the ribs touched the sand and the upper surface was flush with the floor. Minor adjustments were made by inserting wedges under the bottom at various points until the pattern lay level, straight and *out of wind*. Facing sand then was rammed under the pattern followed by heap sand until the pattern was covered about half-way to the top. A row of cinders was laid along both sides at this point and then the remainder of the space between the pattern and walls of the pit was filled with sand and rammed to the top. Rods were laid in the corners of the ribs as the ramming progressed and a row of long rods was bedded on each side immediately under the flange to reinforce the wall and assist in supporting the cope after the pattern had been withdrawn.

Two upright gate pins were rammed up at one end and one gate pin at the other end. In each case horizontal draw gates served to connect the uprights with the lower part of the pattern and in addition two gates were cut in the joint at each end after the pattern had been removed. This distribution of gates was decided upon primarily on account of only having one crane. The casting was too long to pour from one end, but yet on account of the time involved in handling the metal it was considered advisable to pour the greater amount from one end and simply provide for pouring a relatively small amount at the other end. The 7-ton ladle first was filled and set down in a pit provided for the purpose immediately back of the double runner. The 2-ton ladle then was filled and set up on suitable supports back of the single runner. In pouring the mold the larger ladle was about half emptied before the stream was started from the small ladle.

FIG. 8—PRINTING PRESS ROLLERS ARE MOLDED IN DRY SAND, TWO IN A FLASK—A COMBINED WHIRL, STRAINER AND HORN GATE INTRODUCES THE IRON TO THE BOTTOM SIDE OF A HORIZONTAL MOLD

Making the Cores

The dry-sand core designed to form the interior of the casting was made in four sections for convenience in handling. Molding sand and sharp sand, in equal proportions, bonded with a dry binder were used in the core-sand mixture. The large amount of molding sand was required to give cores a *body* and prevent them from sagging before they were dried. A large quantity of coke was rammed in the interior of each core, partly to provide an open vent and partly

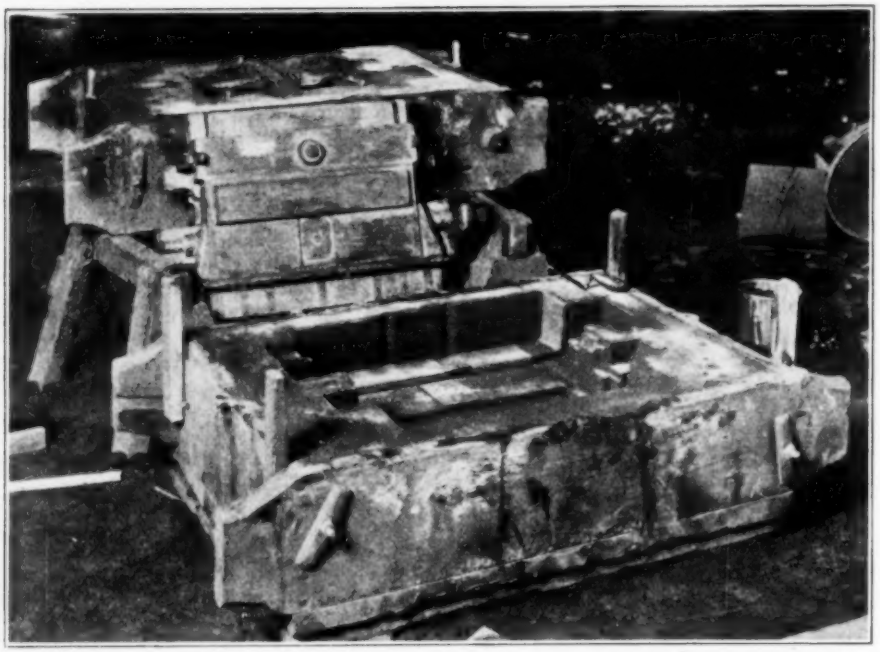


FIG. 6—SMALL GASOLINE ENGINE CYLINDER BLOCKS ARE MADE IN GREEN SAND MOLDS. TWO UPRIGHT RUNNERS AT THE BACK OF THE CRANK-CASE CORE PRINT CONDUCT THE IRON TO A ROW OF FLAT GATES ON THE BOTTOM FLANGE

because it was necessary to furnish a core that would offer a minimum of resistance to the casting while contracting. Vent passages from the interior led through the end faces of the cores that came in contact with each other and also through the upper faces where they came in contact with the cope. Pieces of scrap pipe and rods were employed freely for reinforcing the cores. Four long *S*-hooks were set in the four corners of a rectangle located about a foot from each end and the same distance from each side of the core were rammed up in each core. The lower end of the *S*-hook embraced one of the long reinforcing pipes and the upper end was flush with the face of the core.

Setting the Cores

After the mold was dried, the bottom was covered with pieces of board corresponding to the desired metal thickness of the casting. The sections of core were rolled over off their respective plates, picked up by the crane and lowered into the mold until they came to rest on the boards. Flour was sprinkled all over the face of the cores and then the cope was tried on and lifted off again. The flour impression on the face of the cope indicated whether the contact had been close and also outlined the position of the various *S*-hooks. Sand was removed from between the bars of the cope above each *S*-hook impression to permit the insertion of lifting hooks later. The upper face of each core was examined and where it was found that the cope had not rested evenly, sufficient sand was added to insure a close and firm contact when the cope was set on finally. Additional holes were punched through the cope at those points where the flour indicated the presence of a vent opening in the face of the cores.

Cope Carries Cores

The cope was replaced and then a long hook-bolt was lowered through each opening until the hook at the lower end engaged the *S*-hook in the core. The nut on the upper end of the bolt was screwed down tightly on a suitable washer resting on two short rail sections spanning two bars in the cope. After all the bolts had been tightened, the cope once more was lifted, this time carrying all the cores suspended in their proper relative position from its lower face. While the cope hung suspended from the crane the pieces of board lying in the bottom of the mold were removed and then the cope was returned to place and prepared for the reception of the iron. The upward *lift* on the cope of this mold was approximately 60 tons and it was considered advisable to place about 20 tons of weights on top of the regular cast-iron binders secured at each end by bolts anchored to the bottom plate. Theoretically the binders were strong enough to hold the load, but the added weight served as an insurance feature.

Printing press rollers for color and lithograph work are made in a wide variety of sizes and styles, some with openings along the side, some plain; short ones with the spindles cast on and longer ones with a steel spindle placed in the mold and the iron poured around it. Irrespective of dimension and style all must conform to one standard of excellence. The face of the casting is machined all over and must present a perfect, polished surface before it is assembled in the press. Consequently the iron must be absolutely clean and exceedingly close grained. The first feature is secured by the method of molding and pouring and the second by the use of from 20 to 30 per cent steel scrap in the mixture, depending on the size of the casting. The use of from 5 to 10 per cent of a special chrome-nickel bearing pig iron made by the Bethlehem Steel Co., also has been found beneficial in promoting a close dense grain, not only in the rollers but in other castings where this feature is one of the essentials.

The drag of a roller mold is shown in Fig. 8; a pair of cores in Fig. 1, and a pair of castings at the extreme left in Fig. 2. Occasionally a roller is made singly, but usually they are molded in pairs in dry-sand molds. Considerable economy in time, floor and oven space, and amount of sand, is effected by molding two patterns in one flask. The molds are poured while lying in a horizontal position on the floor. A single runner through the cope communicates with a whirl gate on the joint through which the iron passes under a strainer core leading to a long horn gate. Details of the gates are shown quite clearly in Fig. 8.

Core Made in Two Parts

A pair of cores for these rollers in the process of assembling is shown in Fig. 1. The core is made in two parts and dried and then the parts are rubbed to a bearing, calipered and pasted and bolted together. The joint is daubed and blacked and the patch either is dried with a torch or the core is placed back in the oven. The core hangs in the cope in an inverted position to that shown in Fig. 1 and the entire core is surrounded with iron with the exception of a small part of the rectangular print on which the core is shown resting on the plate. Vents scratched on the joint before the two parts of the core are pasted facilitate the passage of the gas generated in the lower part of the core in its journey upward through vent holes provided in the upper half and leading to suitable vent holes in the cope part of the mold.

Experiment with Electric Iron

Tests Made in Melting Gray Iron in a Rotating Electric Furnace—Data Show Changes in Composition of the Metal During Melting, also Power Consumption

BY H. M. WILLIAMS and T. B. TERRY

THE General Motors Research Corp. in September, 1920 installed a Booth rotating electric furnace in its experimental foundry. The furnace is of the regular standard type, and has a capacity of 250 to 280 pounds of metal. This furnace has been used extensively for the melting of cast iron. To date 750 heats have been melted. The original purpose of this installation was to have available a small unit which could be used for melting either ferrous or nonferrous metals. The installation consists of a base and two shells; one for melting ferrous, the other for melting nonferrous metals. In actual practice both shells have been used for melting cast iron, one shell always being lined and available in case of emergency, such as failure of the lining in the shell in use. The shells can be changed in about one hour. It was found desirable to have some way to utilize the iron which was melted for experimental purposes and a molder was put on for this purpose. As we have our own pattern shop at the plant, and a large number of gray iron castings are required from day to day, it soon was found that it would be convenient to produce a larger quantity of these castings in the experimental foundry. As a consequence we now have four molders and two coremakers engaged in the production of molds for castings. The iron is all melted in the Booth furnace, which has averaged 15 heats per week. As many as five heats per day have been made in rush periods.

The furnace is equipped with a Pittsburgh transformer of 75 kilovolt-ampere capacity. It operates at 6600 volts on the high tension side, and is provided with taps for 115, 100, 90 and 80 volts on the low tension side. The automatic electrode control was made by the General Electric Co.

The tiles used for linings in this furnace are made by the Laclede-Christy Clay Products Co. These tiles are from a high alumina clay, supposed to be neutral and not to react with the metal.

In the early operation of this furnace and on account of the shape of the tiles and our lack of proper equipment for charging the furnace we got only 80 heats per lining. The lining cost at this rate is high. We have been able by a change in the shape of the tile, namely, recessing the cylindrical tile into the end tile, and with suitable charging equipment and attention to the furnace to obtain as high as 225 heats before it was necessary to replace the lining. These furnace linings are operating exclusively on cast iron, and in temperature measurements taken with an optical pyrometer, we find that the lining is heated as high as 1760 degrees Cent. and the temperature can be controlled. In the operation of the furnace it is necessary to watch the linings carefully and patch any holes as quickly as possible. We had difficulty at first with the iron penetrating through the joint between the cylindrical tile and the end tile, but by recessing the cylindrical tile into the end tiles, this difficulty has been entirely overcome. As an additional precaution, in building up the lining, we put in a fillet of cement in each end. This strengthens the corner and also prevents the iron from penetrating the joint. The electrodes used are standard 2.5-inch diameter graphite electrodes joined with nipples. The electrode consumption of the first heat averages about 1.25 pounds, and of subsequent heats about 0.60 pound per 250 pounds charge. In the early operation of this furnace, the electrode breakage was excessive on account of the operator not being sufficiently experienced to know just when to start rotation. If rotation is started too soon, the unmelted chunks of metal will be carried up on the sides and fall back, breaking the electrodes. The furnace is operated on the 80-volt tap, and the regulator is set for 1000 amperes. We are able to get 60 kilowatts per hour input into the furnace at this setting. On Monday mornings 100 kilowatt hours are used to preheat the furnace before charging. After this preheat, the first heat is taken off with an expenditure of from 145 to 165 kilowatt hours. On other week days the furnace is charged after the last heat of the day and allowed to set overnight with no current on. The first heat

Makes Semisteel in Electric Furnace

THAT steel added to mixtures melted in the cupola increases the strength of the product is well known, but its influence on metal melted in the electric furnace has not been so clearly indicated as it is by the tests in this article. The transverse strengths of standard arbitration bars made from borings, from a mixture of pig iron and back scrap, and from an all-back-scrap charge are shown in Table II to average less than 3400 pounds. The bars made from borings had an average transverse strength of 3333 pounds, while those from a mixture of pig iron and scrap were almost identical in transverse strength, averaging 3317 pounds, and the bars made from back scrap showed only a slightly higher transverse strength, averaging 3433 pounds. Thus the grand average of the three mixtures shows a transverse strength of 3361 pounds which can be contrasted with the average of 4480 pounds as shown by the average transverse strength of the first five bars in Table II, made from a mixture to which 20 per cent steel had been added. Of course, the compositions of the different bars vary; but in the lot of bars from the semisteel mixture, irons high in both carbon and silicon are found and little difference is shown between such bars and those having lower carbon and silicon, at least none of the semisteel bars are in the same range of transverse strength as the bars from all-iron mixtures. Therefore, it may be concluded that the effect of steel in semisteel made in the electric furnace is similar to its effect in cupola mixtures. More information as to the basic law behind this phenomenon is needed to allow the metallurgist to go ahead intelligently.—Editor.

Paper presented at a general meeting of the American Electrochemical society, held recently in Baltimore.

Table I

Some Analyses of Electric Furnace Iron with Steel Additions

Heat No.	Total carbon Per cent	Manganese Per cent	Silicon Per cent	Phosphorus Per cent	Sulphur Per cent	Chromium Per cent	Nickel Per cent	Load, pounds	Modulus of rupture, pounds	Deflection, inch
296	3.24	0.60	2.13	0.58	0.065	...	...	4440	69,250	0.185
282	2.97	0.57	2.10	0.54	0.069	...	...	4680	73,000	0.175
534	3.23	0.76	2.47	0.69	0.025	...	...	4250	66,300	0.222
537	3.16	0.70	2.45	0.155	0.024	...	...	4350	67,900	0.200
534	3.01	0.50	2.00	0.138	0.026	...	...	4680	73,100	0.183
455	3.07	0.70	2.62	0.22	0.037	0.40	0.20	4480	69,800	0.169
465	3.11	0.58	2.69	0.248	0.038	0.36	0.18	4520	70,500	0.172
489	3.02	0.65	2.72	0.120	0.030	0.25	0.12	4570	71,400	0.175
493	3.31	0.68	2.28	0.120	0.025	0.30	0.15	4460	69,500	0.230
571	3.03	0.56	2.58	0.085	0.023	0.28	0.14	4640	72,300	0.241

is taken off the following morning with an expenditure of 165 to 175 kilowatt hours. In melting borings, the first heat is taken off in about 2¾ hours using 170 kilowatt hours; the second heat in 1¼ hours using 80 kilowatt hours; the third heat in 1 hour, 10 minutes using 70 kilowatt hours. These figures will be influenced by time lost in delays, such as waiting for molds, etc.

Having determined the amount of energy input necessary to melt the charge, it is a simple matter to avoid electrode breakage due to rotation. After sufficient energy input, the operator gives the furnace three or four half turns and watches the ammeter for any surge. If none, the charge is sufficiently melted to proceed with rotation.

A great deal has been said with regard to the fact that rotation does not mix the melt. If the melt were in a true cylindrical container, this would no doubt be true but on account of the irregularities on the inside surface of the cylindrical lining, we have found that the charge is very thoroughly mixed. We have not been troubled with segregation in iron from this furnace.

Fig. 2 shows the special device which has been found satisfactory for charging pig and large pieces into the furnace. Such materials as borings, steel punchings and small castings are thrown in with a shovel. A device has been made which allows the addition of ferroalloy through the electrode hole.

It is found that in charging over night the charge should be made up of pig and heavy castings, rather than material like borings, which oxidize badly and cause a loss of carbon and silicon.

On account of the construction of this furnace, it is practically impossible to handle a slag. For this reason, no fluxing material is added with the charge. Any slag which is obtained is probably a combination of iron oxide and the lining. It is necessary from time to time to pull out a small quantity of this material after a heat is poured.

The construction also makes it difficult to make additions to the charge after melting has started, and it is impossible to look in and see the condition of the bath at any time unless the door is opened, which causes the interior to cool down rapidly. For this reason mixtures are made as complete as possible and charged at once into the furnace. Deoxidizers, or other small additions, are made through the electrode hole as already noted.

Pouring is done by catching the metal in heated hand ladles supported on a special fixture attached to the furnace. It is important to have the ladles well heated before receiving the iron. The first ladle of iron is not as hot as the second and subsequent ladles on account of the iron having to run out over the cold spout.

The temperature of the metal is controlled by paying strick attention to the power, that is, the higher the power the higher the temperature. By experience with the types of castings to be made, the sections, composition, etc., and with power preheating of ladles satisfactory casting conditions have been obtained.

Specifications for gray iron used in

Table II

Physical Tests of Electric Furnace Iron

Heat	Total carbon	Manganese	Silicon	Phosphorus	Sulphur	Load	Mod. of rupture	Deflection
				Borings				
151	3.31	0.50	2.46	0.58	0.098	*3460	54,000	0.154
38	3.18	0.46	2.11	0.72	0.090	3220	50,200	0.171
55	3.26	0.57	2.29	0.51	0.088	3330	52,000	0.183
				Pig and Back Scrap				
244	3.25	0.74	2.18	0.10	0.025	3280	51,200	0.175
291	3.26	0.57	2.21	0.24	0.030	3370	52,600	0.212
339	3.28	0.76	2.20	0.24	0.044	3300	51,500	0.157
				Back Scrap				
63	3.28	0.50	2.23	0.51	0.082	3610	56,300	0.159
69	3.30	0.50	2.15	0.52	0.087	3370	52,500	0.195
70	3.23	0.47	2.32	0.48	0.086	3420	53,400	0.175

*Standard A. S. T. M. test bars.

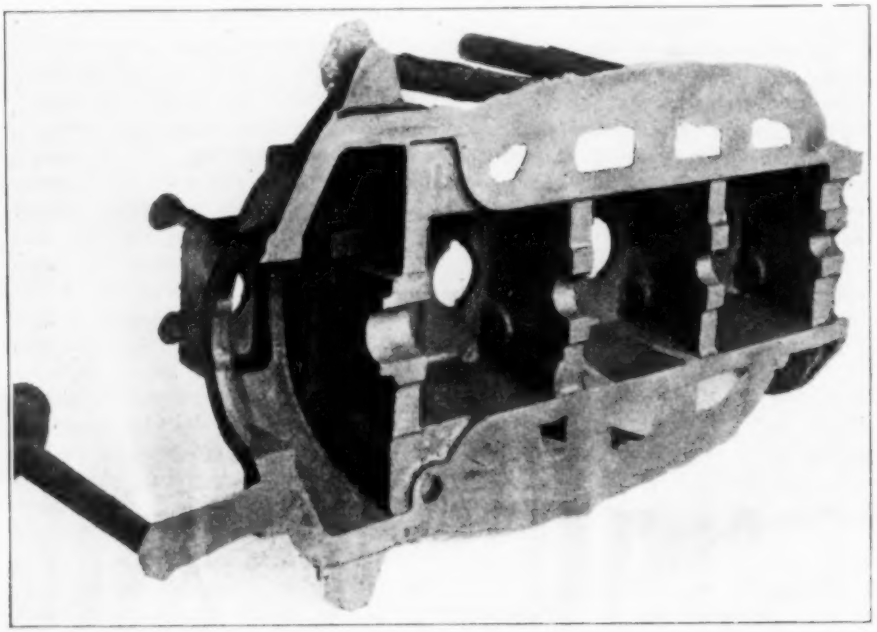


FIG. 1—CRANKCASE MADE FROM IRON LOW IN PHOSPHORUS

Table III

Loss of Chemical Elements in Electric Furnace

	Total carbon, per cent	Manganese, per cent	Silicon, per cent	Phosphorus, per cent	Sulphur, per cent
Heat No. 748—Borings Charged					
Charge analysis	3.44	0.63	2.12	0.244	0.077
	3.39	0.63	2.16	.....	.....
Heat analysis	3.39	0.66	2.13	0.248	0.077
	3.41	0.66	2.17	.....	.....
Heat No. 749—Pig Iron Charge					
The charge was made up of two pigs from the same car lot. The analyses and weights of each pig were as follows:					
78 pounds, pig No. 3, lot 14	3.41	0.46	3.31	0.110	0.048
	3.39	....	3.29	.....	.....
44 pounds, pig No. 4, lot 14	3.60	0.42	3.25	0.114	0.045
	3.49	....	3.24	.....	.....
The estimated analysis of charge based on these analyses was	3.47	0.45	3.28	0.112	0.047
Actual analysis of heat	3.56	0.46	3.14	0.114	0.058
	3.61	....	3.13	.....	.....
Heat No. 751—Pig Iron Charge					
This heat was made up in the same manner as heat No. 749.					
46 pounds, pig No. 3, lot 13	3.44	0.55	2.99	0.42	0.014
	3.81	0.55	2.97	.....	.....
49 pounds, pig No. 4, lot 13	3.78	....	3.55	0.036	0.014
	3.60	0.55	3.57	.....	.....
The estimated analysis of charge based on these analyses was	3.45	0.55	3.27	0.039	0.014
Actual analysis of heat	3.42	....	3.24	0.022	0.023
	....	....	3.22	.....	.....
Heat No. 754					
This heat was made up in the same manner as heats 749 and 751.					
51.5 pounds, pig No. 1, lot 13	3.76	0.58	2.96	0.048	0.006
	3.65	....	2.97	.....	.....
54 pounds, pig No. 2, lot 13	3.81	0.55	3.55	0.036	0.014
	3.78	....	3.57	.....	.....
The estimated analysis of charge based on these analyses was	3.75	0.54	3.26	0.042	0.010
Actual analysis of heat	3.69	0.55	3.12	0.042	0.024
	3.62	....	3.12	.....	.....

automobile practice call for low phosphorus content, which means less fluidity, and consequently a higher pouring temperature. Fig. 1 is a view of a crankcase made from iron with 0.04 per cent phosphorus, 3.00 per cent carbon and 2.50 per cent silicon. This view is shown to call attention to the high heat which must be necessary for the casting of thin sections with long runs from metal of this analysis. The metal thickness in this case is 0.16 inch.

Metal losses were determined by weighing the charge into the furnace against the weight of castings, gates, sprues, etc., recovered. It is necessary to take an average figure for this value, as it often happens that it is impossible to drain the furnace completely after each heat. This difficulty is due to wear of lining, slag running down into pouring hole, etc. With pig iron and back scrap charges, the recovery has averaged 96 per cent. When operating on clean borings, free from rust, the recovery has run from 92 to 94 per cent.

As far as we are able to find by careful analysis, the loss in chemical elements of the materials used in the charge, and of the heats poured, is negligible. The tests recorded in Table III are cited as confirmation of this.

It should be noted that in the case of the heat of all borings, where it is possible to obtain a representative sample, the difference in analysis of the material charged and the metal poured are within the limits of error of chemical analysis. In the case of all-pig heats, it may be noted that there is a marked difference in the analysis of pigs from the same shipment. For instance in lot No. 13, the carbon ranges from 3.35 to 3.81 per cent while the silicon varies from 2.97 to 3.57 per cent. Manganese, phosphorus and sulphur are quite constant. In spite of these variations, the actual analysis differs from the estimated analysis at most, only 0.22 per cent carbon and 0.15 per cent silicon.

This type of furnace is ideal for handling borings, turnings, etc. As soon as the material is charged, rotation can be started which constantly turns over the material preventing melting of a pool in the top of the charge.

The quality of the borings must be good; they should be stored inside to prevent rusting. Rusty borings will cause excessive chemical losses in the melt. Oil on the borings will cause no more trouble than in the melting of oily brass or bronze turnings. The shrinkage of the iron produced from melting borings is no different from that in melting pig and scrap. This has been determined by making K-bars and castings nonuniform section and comparing with similar castings made from pig and scrap melted in both electric furnace and cupola.

Table II contains some comparative physical tests of iron produced from heats of borings, pig and back scrap, and from all back scrap.

All these heats have been selected so that the iron has the same chemical analysis, and having been poured under the same conditions the values are strictly comparable. It would seem from these results that under the melting conditions in this furnace, it makes no difference in the quality of the metal whether pig or scrap is used, provided the chemical analyses are the same.

Table I records a few heats selected from every day production record. These results were selected to show the possibilities in the physical properties of irons melted in this furnace. The first five heats were made from pig and back scrap, to which 20 per cent of steel has been added. The last five heats were made from pig, back scrap, 20 per cent steel and 10 to 12 per cent pig iron made from an ore containing nickel and chromium.

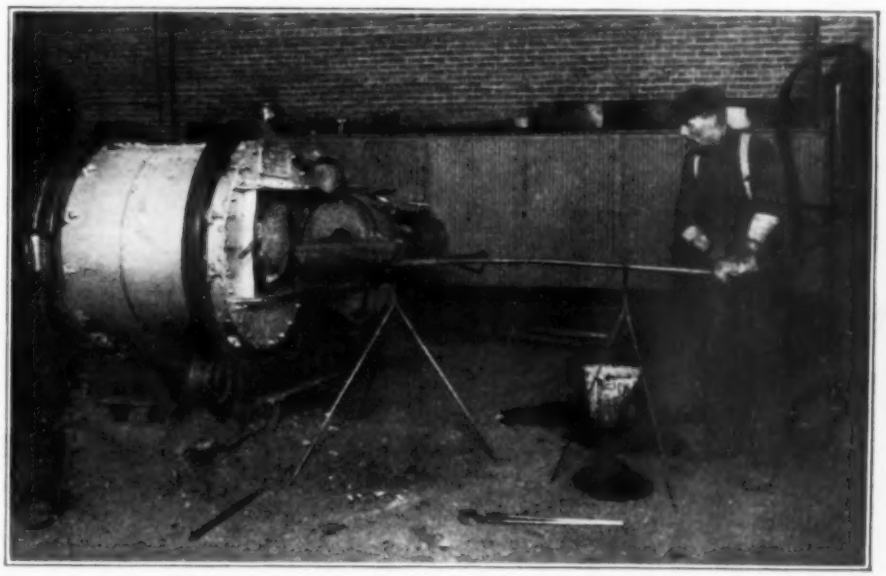


FIG. 2—SPECIAL DEVICE IS USED FOR CHARGING PIG IRON

Aluminum Melting Practice-IV

Furnaces for Aluminum the Same as Those Used for Brass Except the Iron-Pot Type—Recent Tendency toward Furnaces of Higher Capacity —Many Different Fuels Used

BY ROBERT J. ANDERSON

AT THE present time, the selection of the proper type of furnace for a given set of operating conditions is made especially difficult by the many types available, and more particularly by the lack of comparable data regarding them.

Light aluminum alloys are, or have been, melted in all kinds of furnaces which have been used for brass and bronze. The iron-pot furnace, so widely used for the melting of so-called white metals, is the only one employed for aluminum alloys not used for brass and bronze; in fact at the present time, the iron pot furnace is regarded by many foundrymen of long experience as the preferable type.

The type of furnace depends upon whether aluminum or one of its light alloys is being melted, as well as whether, in the case of aluminum, the metal is melted simply for re-pigging or for casting into rolling ingots; and in the case of the light alloys, whether they are to be poured into sand castings or used for the production of die castings or permanent-mold castings, or are poured into rolling ingots. The smelting of aluminum-alloy borings and related aluminum-bearing scraps presents a distinct problem, and a variety of furnaces is used for this purpose.

When speaking of furnaces for melting aluminum, it will be generally understood to refer to melting prior to casting into rolling ingots, although, of course, all direct metal from the reduction cell is remelted, and either cast into rolling ingots or poured into pigs. Various furnaces have been used for remelting the reduction-cell metal, but in the United States the open-flame reverberatory furnaces, fired by gas, oil, or coal, appear to have been employed principally.

Furnaces in Foundry Practice

It is in light-alloy foundry practice that the greatest variety of furnaces is employed, and the following types are at present in daily use in the aluminum foundries of the United States: coal, coke, oil, and gas-fired reverberatories; oil and gas-fired stationary and tilting iron-pot furnaces; coal and coke-fired natural and forced-draft pit furnaces, using a crucible; coke, oil, and gas-fired stationary and tilting crucible furnaces; oil and gas-fired open-flame tilting and rotating furnaces; and two or three kinds of electric furnaces. The stationary and tilting iron-pot furnaces are favored considerably in this country, particularly by large foundries, but open-flame furnaces are being used more widely now than a few years ago. In small foundries, and in foundries where only a minor part of the output is in light aluminum alloys, pit or crucible furnaces are used largely. Electric furnaces for melting light aluminum alloys are now receiving considerable attention and a few installations have been made.

The tendency in recent years toward the use of furnaces of large capacity, such as reverberatories, open-flame barrel-shaped furnaces, and electric furnaces,

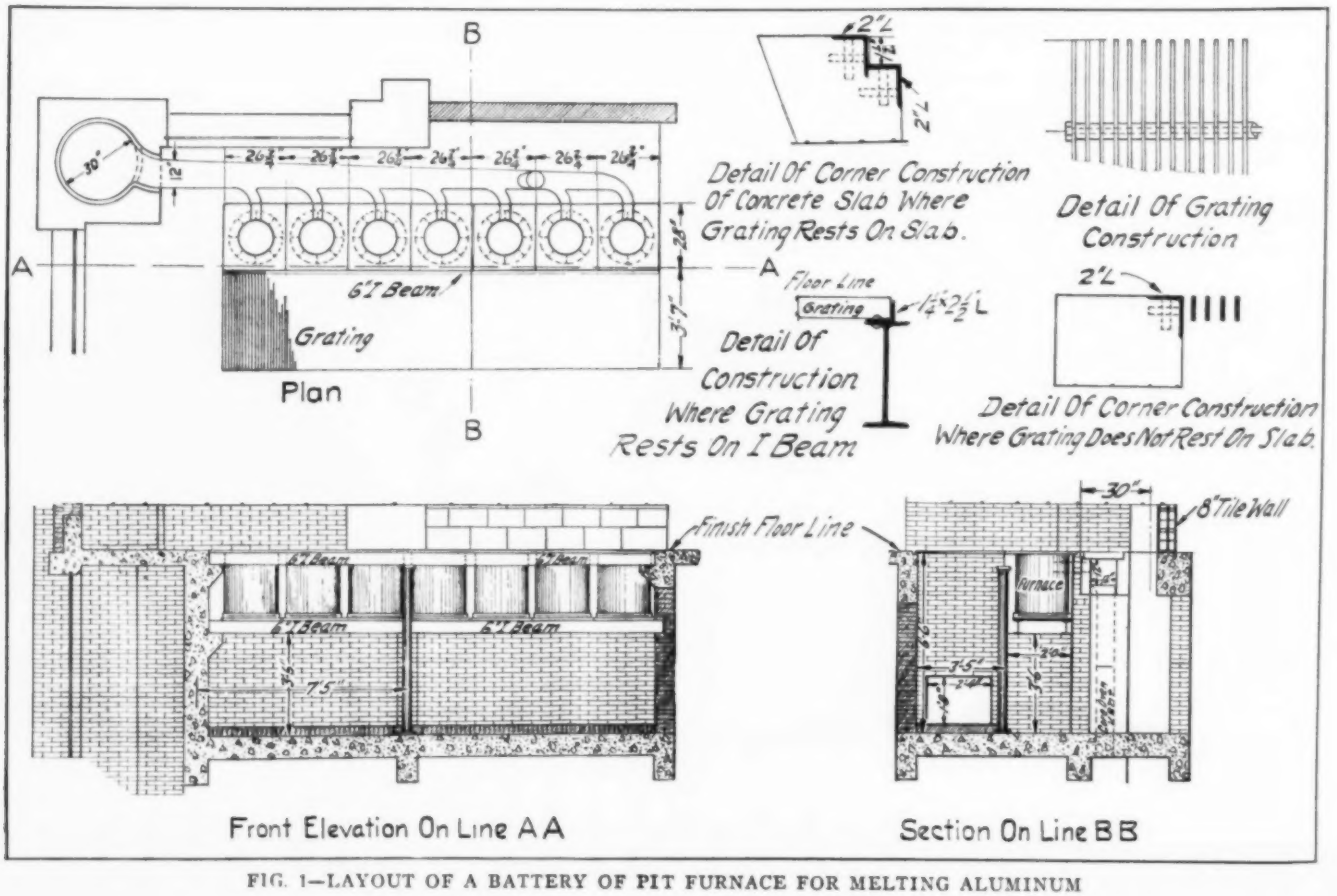


FIG. 1—LAYOUT OF A BATTERY OF PIT FURNACE FOR MELTING ALUMINUM

has come through the enlargement of plant capacity. Where a foundry is turning out 5,000,000 to 15,000,000 pounds of finished castings per year, melting in units of small capacity requires a large installation, i. e., many furnaces. One type of barrel-shaped open-flame furnace can melt at least 2,000 pounds of metal per hour, and the advantage in operating larger units than stationary crucibles or iron pots is apparent in foundries where the daily output amounts to thousands of pounds.

In modern aluminum-alloy die-casting practice, the alloys are melted in small cast-iron pots, which may be considered as part of the die-casting machine proper. Usually the fuel is gas. In both die-casting and permanent-mold casting work, it is standard practice to make up the alloys in an alloying furnace and run them into small pigs. The prepared alloys are then simply delivered to the die-casting machine for remelting. Stationary iron-pot furnaces are preferred for alloying, although several other types have been used. In the case of permanent-mold casting practice, small iron pots fired by gas are preferred for melting the alloys prior to casting.

Smelting Aluminiferous Scraps

In the case of smelting furnaces for aluminum and light aluminum-alloy borings, scrap, and dross, the domestic practice is not standardized, and many different types of furnaces are employed. For smelting borings and other light scrap for the production of so-called casting aluminum, and in making secondary light aluminum alloys stationary and tilting iron-pot, reverberatory, pit, and open-flame tilting and rotating furnaces are employed commercially. Strictly speaking, furnaces used for running down borings, dross, and other high aluminiferous scrap should not be called refining furnaces, since no refining of the material is accomplished. That is to say, the usual impurities, with the exception of zinc, cannot be removed by a melting operation. It has been reported that one firm has worked out a process for recovering substantially pure aluminum from scrap by removing the impurities in a melting furnace, but no details are available.

Experiments have been made by Gillett on electric melting of borings, and during the past two years, a number of companies have made preliminary studies of the electric melting of aluminum and aluminum-alloy scrap. No commercial application has yet been made, so far as is known.

The primary object in smelting aluminum and aluminum-alloy scrap is twofold; simple remelting for the purpose of pigging clean choice scrap, and obtaining high recoveries on dirty borings and low-grade scrap. The furnace to be employed should be governed to a certain extent by the kind of material smelted.

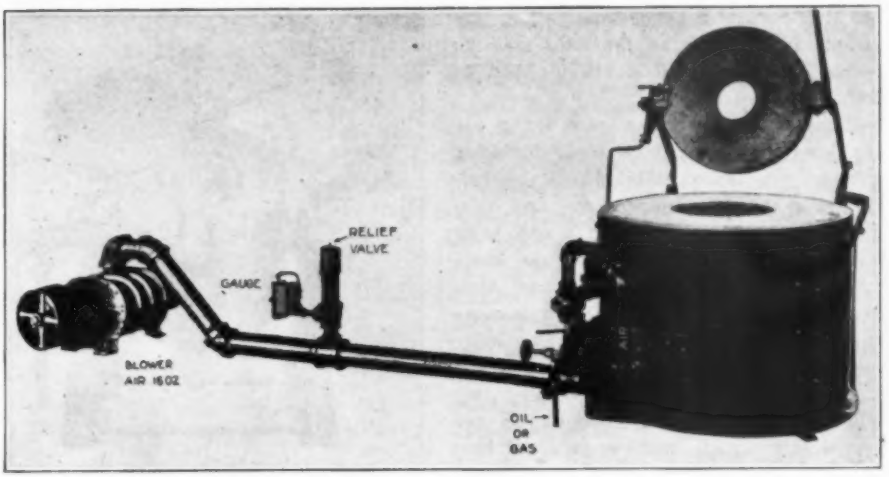


FIG. 2—STATIONARY CRUCIBLE FURNACE WITH BLOWER AND CONNECTIONS

Intermediate copper-aluminum alloys and other so-called hardeners for foundry practice have been made in various kinds of furnaces. Generally speaking, the stationary iron-pot furnace is preferred for melting the aluminum in the manufacture of 50:50 copper-aluminum alloy, the copper being melted either in pit or in crucible furnaces. Of course, furnaces other than the iron-pot furnace are used for melting the aluminum in the preparation of these alloys. In cases where intermediate alloys are made of aluminum and a metal of high melting point, such as nickel, cobalt, or manganese, an electric furnace may be advantageously employed. A small Rennerfelt electric furnace has been used commercially for this purpose. The Detroit indirect-arc rocking electric furnace has been used for melting aluminum bronze turnings, to which aluminum was subsequently added for the manufacture of 50-50 copper-aluminum alloy. The preparation of rich alloys for use in aluminum-foundry practice has already been described by the writer*.

Aluminum alloys are still melted in the usual types of brass pit furnaces, particularly in foundries where only a minor part of the output is in these alloys. Natural and forced-draft coke and coal furnaces are generally built in an actual pit below the floor level; so-called pit furnaces, fired by oil or gas, usually are not, although they can be. The latter are generally referred to as crucible furnaces in contradistinction to actual pit furnaces fired by coal or coke, and they are so included here.

In the case of natural-draft pit furnaces, fired by coal or coke, a usual form of construction consists of a pit about 6 to 8 feet wide and the same depth, and of varying length, depending upon the number of furnaces. The pit is ordinarily divided in two, about half the width being used for the setting of the furnace and the remainder for the runway, which is used for removing ashes. The latter is covered either with an iron grating or with iron plates. The individual furnaces are built side by side in the pit, suported on iron griders set about 3 to 4 feet down in the pit. Gratebars, which are generally hinged, make up the bottoms of the individual furnaces. Any fuel or ash on the gratebars may be dropped into the pit below by control chains, which run to the floor above. At the rear of each furnace there is a square or rectangular flue leading into a larger flue at the back of the whole battery, and this in turn connects with the stack. In melting, the crucible is set on the fuel previously placed on the grate bars, and additional fuel is placed around the sides of the crucible. Each furnace; that is, hole, is covered with some kind of a cover, usually a cast-iron dome or flat shaped cover, which may either be swung aside or otherwise readily removed. The construction of pit furnaces using forced draft is substantially the same as that

FIG. 3—SECTION OF A STATIONARY CRUCIBLE FURNACE IN WHICH THE AIR IS PREHEATED

*Anderson, R. J., Manufacture of rich copper-alloys or hardeners, Chem. and Met. Eng., vol. 23, 1920, pp. 617-621.

of the natural-draft furnace, but the ash-pit is enclosed so that air may be forced into it instead of being open to the air.

Richards* states that a good lining for any kind of a crucible is made by using calcined magnesite, fully shrunk by calcining at a high temperature, and then ground finely and made into a stiff paste with molasses. The crucible is carefully lined with the paste and then heated slowly to redness. On cooling any cracks are carefully filled with more paste, and the crucible is baked again. He states that it has been shown that aluminum will take up about 0.25 per cent silicon on one melting at a red heat in a plumbago crucible, and that magnesite-lined crucibles are therefore desirable. It is stated** in an early article, that aluminum and its alloys should be melted in pit coke furnaces using plumbago crucibles, and that charcoal, oil, or gas can be used as the fuel, but not anthracite or bituminous coal because of the gases evolved by the coals. Richards states that melting for aluminum is ordinarily performed in plumbago crucibles, and that the metal should not be overheated.

In a description of a pit coke furnace fired by a mechanical stoker an anonymous writer states that the fuel consumption in the ordinary pit coke furnace when melting aluminum is about 0.90 pound of coke per pound of metal. Again it is stated that aluminum can be melted in small lots most satisfactorily by employing a plumbago crucible in a coke pit. Knight†, in a patent, has suggested the use of a ring or flange extending laterally beyond the top of the crucible in pit coke furnaces with the object of deflecting the hot gases around the crucible and thereby conserving heat. It is said that coke-fired, pit crucible furnaces, such as are used largely in ordinary brass practice, were discarded for regular practice in melting aluminum alloys in one plant. It is also stated that in the same plant when some metal is occasionally melted in these furnaces the crucibles are given an initial heat of bronze, since aluminum alloys have a tendency to soften a new crucible. When crucibles are used for aluminum alloys exclusively it is stated that they are assured a long life, owing to the low temperature which is employed, and that frequently 100 heats have been taken from one crucible. Vickers†† states that in melting aluminum and aluminum alloys in plumbago-clay crucibles, it is essential that the crucible should be given an internal coating of fire clay so as to prevent contact with carbon. Also he* has described several pit furnaces of different designs, as also has Krom** and Gillett*** Fig. 1 shows the layout of a battery of pit furnaces in a small foundry.

*Richards, J. W., Aluminum: its history, occurrence, properties, metallurgy and applications, including its alloys, Philadelphia, third ed., 1896, H. C. Baird and Co., p. 444.

**Anon., Casting aluminum, THE FOUNDRY, vol. 11, 1899, pp. 128-129.

†Anon., Metal melting furnace, *The Metal Ind.*, vol. 5, 1907, p. 299.

††Vickers, C., How we may conserve our metal resources, THE FOUNDRY, vol. 45, 1917, pp. 209-214.

FIG. 4—TILTING CRUCIBLE FURNACE

Stationary Crucible Furnaces

Stationary crucible furnaces are used to a considerable extent for melting light aluminum alloys in foundries. The shell may be set down partly in a pit, or it may be above the level of the floor, generally the latter, and built as a separate unit. In the case of pit furnaces, as in the usual brass pit, the furnace is built below the level of the floor, and a number of pits are built in a bank. In the case of stationary crucible furnaces, oil and gas are nearly always the fuel, while coal and coke are burned in pit furnaces. The capacity of the ordinary stationary crucible furnace is small, these being built to take up to No. 600 crucibles, but No. 60 to 100, with capacities of 60 to 100 pounds of No. 12 alloy, are common sizes.

*Vickers, C., Melting and casting nonferrous metals, THE FOUNDRY, vol. 42, 1914, pp. 362-366.

**Krom, L. J., The development of melting furnaces, *The Metal Ind.*, vol. 7, 1909, pp. 287-289; 324-326; 358-361; 404-406; 436-440; and vol. 8, 1910, pp. 80-81.

***Gillett, H. W., Brass-furnace practice in the United States, Bureau of Mines Bull. 73, second ed., June, 1916, pp. 19-24.

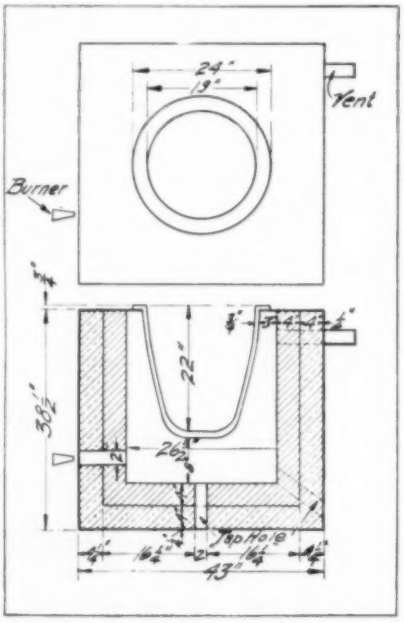


FIG. 5—TOP VIEW AND CROSS SECTION OF A SINGLE UNIT STATIONARY IRON-POT FURNACE

Pour From Crucibles

Crucible furnaces are run on intermittent heats, and usually the melting crucible is also employed for pouring, that is, after the charge is melted, the crucible is lifted out of the furnace, taken to the molds, and there poured. In stationary crucible melting there is ample opportunity for the products of combustion to come into contact with the alloy during melting, and contamination from the fuel may occur that would not be possible in iron-pot melting. In the ordinary crucible furnace, the crucible is heated over its exterior surface by the combustion of the fuel from burners, and the waste gases are discharged through a large hole in the furnace cover. The flames are projected tangentially so that they are given a rotary and upward motion around the crucible, and the incandescent gases are in intimate contact with the alloy during melting.

The low temperature employed in melting gives a long life to the crucible but the corrosive action of aluminum on plumbago crucibles is greater than the action of brass or bronze. The design of the stationary crucible furnace is extremely simple. It consists of an iron or steel shell, cylindrical in shape, lined with refractory firebrick. One burner set near the bottom of the furnace, and leading into the interior through a hole in the shell and lining, is generally employed. The melting crucible is set on a refractory block placed on the bottom of the furnace. Details of design vary considerably among different furnace-makers. Some stationary crucible furnaces are built with gratebars below so as to take solid fuel, but this type is not employed to any extent for melting aluminum alloys.

It is stated by Tooth* that in a test 63 pounds of aluminum were melted in a gas-fired stationary crucible furnace in 30 minutes, with 2.8 cubic feet of gas used per pound of metal melted, at a cost of about $0.127 per 100 pounds of metal.

High-pressure gas-fired stationary crucible furnaces were reported in 1912.

*Anon., Melting nonferrous metals with gas, THE FOUNDRY, vol. 37, 1911, pp. 253-254; abst. of presidential address before the London and Southern District Gas Assoc., London, England.

as being used at the Birmingham Aluminum Casting Co., Ltd., Birmingham, England. According to the statements made, the chief advantages of these furnaces are freedom from oxidation of the metal, small radiation losses and ease of control of temperature. The melting cost is low and heats of 100 pounds can be melted in 18 minutes.

Vickers*, in an article on the conservation of metals written during the late war, states that the greatest saving of aluminum can be effected in the melting of the metal or its alloys. He claims that the metal never should be melted in a furnace in which the products of combustion are driven by a blast so as to converge and pass through an opening centered over the crucible. Since the metal is melted without a cover, the rapidly moving and highly heated gases come into contact with the aluminum and enter into reaction with it.

Fig. 2 shows a stationary crucible furnace with the blower connections, while Fig. 3 shows the construction of a crucible furnace in which the air for combustion is preheated by being circulated around the lining.

Detailed data as to the performance of stationary crucible furnaces will be given in a later article of this series.

Tilting Crucible Furnaces

Tilting crucible furnaces are used to a small extent for melting light aluminum alloys in foundries. They are fired by oil, gas, coal, and coke, but mostly by the first two fuels mentioned. Tilting iron-pot furnaces and tilting crucible furnaces are similar in design, but in the latter type a plumbago crucible with a molded pouring lip is used. The tilting crucible furnace consists of an iron shell lined with refractory material; it is set on trunnions and fitted with the necessary tilting mechanism. The small units employed for melting aluminum alloys are always tilted by hand. The crucible is suspended from the top of interior of the furnace.

The capacity of the ordinary tilting crucible is small, but in aluminum-foundry practice a No. 80 crucible is used considerably. The furnaces are built to take up to No. 600 crucibles, but extreme sizes, either large or small, are not used commercially. Tilting crucible furnaces are generally run on intermittent heats, although the practice of using a molten heel may be followed. When a charge is melted, it is poured into ladles or into pouring crucibles for casting into the molds. The products of combustion may or may not have an opportunity to come into contact with the alloy during melting depending upon the design of the the furnace. Generally speaking, however, there is more or less opportunity for the combustion products to pass over the surface of the liquid alloy during melting. In most tilting crucible furnaces, the products of combustion are discharged from a broken annular ring around the top of the crucible, and thence though the hole in the furnace cover. If the waste gases were led out through a vent in the side of the furnace, the possibility of gases coming in contact with the alloy would be prevented.

The method of firing tilting iron-pot furnaces, stationary crucible furnaces, and tilting crucible furnaces is generally the same when oil or gas are used. Some of the tilting crucible furnaces on the market are built in fairly large sizes—to hold up to about 1000 pounds or more of No. 12 alloy. Details of the construction of the tilting furnaces are essentially the same as for the stationary crucible furnaces. Tilting furnaces using solid fuel have been employed for melting aluminum alloys in foundry practice, but only to a small extent.

A tilting crucible furnace having a capacity of 140 pounds per heat and which can be heated and poured every 25 minutes is described in THE FOUNDRY of June, 1910. Fuel oil is used at a pressure of 1.5 pounds, and it is stated that 1 gallon of oil or 300 cubic feet of gas will melt 100 pounds of metal. Plumbago crucibles last for 100 heats in the furnace. Fig. 4 illustrates a typical tilting crucible furnace.

Stationary iron-pot furnaces may be run as separate units, or in a battery of several pots to a bank; the practice of employing two or three pots to a bank has gained favor. Oil or gas are generally used as fuel. At the present time, these furnaces generally are run without covers, although some operators are still strongly disposed to use solid cast-iron covers on small units. Stationary iron-pot furnaces are built in various capacities up to 400 pounds, and 250 pounds is a common size. The pots may either be round or rectangular, but are most frequently round. In the stationary iron-pot furnace, the alloy to be melted is placed in the pot, which is heated over its exterior surface by the combustion of the fuel in the space between the furnace walls and the pot. Normally, the products of combustion do not have an opportunity to come into contact with the alloy during melting. Ordinarily, a liquid heel of 50 to 150 pounds is left in the pot to conserve the heat and also facilitate alloying, and additional cold metal is charged in from time to time during the day. When a charge is melted, and at the proper temperature for pouring, the alloy is ladled out of the pot and poured.

FIG. 6—BATTERY OF STATIONARY IRON-POT FURNACES—NOTE THE FURNACES SET IN A PIT WITH THE TOP OF THE FURNACE SLIGHTLY ABOVE THE FLOOR LINE

Stationary iron-pot furnaces are manufactured by a number of furnacemakers, and in some foundries they are built by the local mechanics. In the case of single units, the furnace consists of a round, square, or rectangular shell lined with refractory brick while the top is covered with a refractory roof leaving a hole for setting the pot. The latter is hung from the top of the furnace and may be supported by wedge-shaped brick or by a refractory stool below.

Flues in the Rear

One burner is used in single units, and it should be placed so that the flames are not directed immediately against the pot, but rather around it, and the products of combustion are discharged through a small flue at the rear. In some furnace installations, the products of combustion are discharged through the flue directly into the air, while in others the small flue leads to a large connecting flue as in pit furnaces, and

*Vickers, C., How we may conserve our metal resources, THE FOUNDRY, vol. 45, 1917, pp. 209-214.

thence to a stack. With one furnace, a small stack may be used. Where two or more pots are placed in one furnace, a burner is used at each end. Charging of the pots is so arranged that the burners are used alternately. Thus, in the case of a two-pot furnace, with a charge of liquid metal in one pot and of cold metal in the other, the burner nearest the first pot would be operating, while the second pot would be preheated by the hot gases. After pouring the first pot, it would be charged with cold meal, the first burner turned off and the second one started. This principle is also applied in some double-chamber tilting crucible furnaces and in double-chamber open-flame tilting furnaces. At the present time the iron-pot furnace is the one most extensively employed from the standpoint of the quantity of metal melted. One of the first of the stationary iron-pot furnaces put upon the market especially for melting light aluminum alloys consists of a cast-iron shell, lined with high-grade fire brick, the metal being melted in a thin cast-iron pot by means of natural or artificial gas. Air under a pressure of 2 pounds is used at the burner. The capacity of the furnace is given as 225 pounds of aluminum, and the time of melting down a charge as 45 minutes. The furnace is run with a cover over the iron pot, and the pot is coated on the inside with a special preparation that increases the life and prevents alloying of the iron with the aluminum. It is stated that about 10,000 pounds of metal can be melted per pot, or a life of about 44 heats. With natural gas at $0.30 per 1000 cubic feet, the cost of melting 100 pounds of aluminum is given at $0.07 for gas alone. This furnace is to be run in single units.

Covered with Firebrick Lid

In an installation of three stationary iron-pot furnaces*, the pots are made of cast iron, flanged at the top where they rest on the furnace body. The top of the pot is covered by a horizontal fire-brick lid, closely fitted to protect the metal from air and other oxidizing influences. The furnaces are fired by both natural and illuminating gas, mixed with air at 1 pound pressure. The metal is melted continuously, each pot having a capacity of about 250 pounds. Owing to the higher temperature to which the pots are subjected, they must be replaced about every two weeks, and the slightest defect in the gray-iron casting frequently results in a break-out after a few heats.

In the discussion of a report of official chemists of the American Institute of Metals* the question of aluminum melting was dealt with briefly. The following two analyses of cast iron pots were given:

Reported by	Horne	Gillett
Total carbon	3.20	3.33
Graphitic carbon	2.40	3.15
Combined carbon	0.80	0.18
Manganese	0.35 to 0.40	0.59
Silicon	1.00 to 1.25	3.03
Sulphur	0.05 to 0.08	0.08
Phosphorus	0.28 to 0.32	0.56

In a description of the foundry of a large automobile company, the use of stationary iron-pot furnaces is mentioned,** but details as to their performance are not given. An installation of ten oil-fired stationary iron-pot furnaces is described.*** Each pot has a capacity of 165 pounds, and about 12 heats per day are taken off, making the daily production about one ton per furnace. In the construction of the furnaces, an oil-burning nozzle is set close to the furnace shell, the air being carried into the combustion chamber through a pipe surrounding the nozzle. The burners are set tangentially to the furnace wall so that the flame will be given a whirling motion around the pot. The pots are cast from semisteel, made up of 40 per cent steel scrap and 60 per cent foundry iron. It is stated that the object of using this mixture is to make a pot which will have a dense structure. These semisteel pots are said to last for 150 to 200 heats. According to Gillett and James,**** the net metal loss in melting pig metal in iron pots for casting purposes is not over 0.33 per cent, if reasonable care is taken, and if the recovery of metal made on remelting the skimmings from the first melting is taken into account. Lea***** states that in the case of iron-pot melting for aluminum alloys, coatings should be applied to the interior of the pot surface, frequently and regularly. The composition of the coatings to be used is not given although in some plants a wash of clay or of magnesite has been applied.

Fig. 5 shows the top view and cross section of a single-unit stationary iron-pot-furnace. Fig. 6 is a view of an installation of stationary iron-pot furnaces in a foundry.

*Anon., Production of aluminum castings, THE FOUNDRY, vol. 33, 1908, pp. 139-144.

*Woods, C. F., Reports of official chemists of the American Institute of Metals, Trans. Am. Inst. of Metals, vol. 6, 1912, pp. 1-11; discussion pp. 11-43.

**Anon., A model automobile foundry, *The Metal Ind.*, vol. 11, 1913, pp. 475-476.

***Anon., Producing Castings for the Automobile Trade; THE FOUNDRY, vol. 41, 1913, pp. 87-92.

****Gillett, H. W. and James, G. M., Melting Aluminum Chips, bureau of mines Bulletin 108, August, 1916, p. 28.

*****Lea, F. C., The Founding of Aluminum, *The Metal Ind.* (London), vol. 15, 1919, pp. 509-511.

The River Foundry Co., Detroit, operating a small jobbing shop, has been sold at auction to satisfy creditors.

Combine Related Firms

The American Carbonic Machinery Co., Wisconsin Rapids, Wis., have been merged into one organization, hereafter being known as the American Carbonic Machinery Co. These two companies have been owned and controlled by the same interests. The American Carbonic Machinery Co., has been a sales and engineering company handling only refrigerating machinery, and the Grand Rapids Foundry Co. has been the manufacturing and parent company. The capitalization of the American Carbonic Machinery Co. has been increased to $200,000, just double that of the original companies.

Organize Brick Company

The Risher Fire Brick Co., recently organized and chartered in Illinois, has its office and warehouse at Eighteenth and Canal streets, Chicago, where a complete stock of high-grade refractories will be carried. Attention will be given to special shapes. H. E. Risher, who is president and treasurer, has been in the refractories business more than nineteen years and thus has had wide experience. The new company will specialize in quick service and engineering advice.

Sells Foundry Property

The Crompton & Knowles Loom Works, Worcester, Mass., has sold its Star Foundry Co. property in that city to Edward D. Priest, Schenectady, N. Y. The consideration was about $20,000. It consists of a one story and basement foundry and 46,253 feet of land, assessed for $22,800. The foundry has not been operated since the war when it was leased by the Standard Foundry Co. The property is to be developed for manufacturing.

Re-establishes Branches

The F. S. Pearson Engineering Corporation, Fisk Bldg., at 57th Street and Broadway, New York City, has re-established its department for industrial management and technical auditing of industries and public utilities. This department will be carried on together with the usual work of financing, developing, design and construction of engineering projects and industrial plants.

To Rebuild Equipment

A department for remanufacturing foundry molding machines has been opened by the Champion Foundry & Machine Co., 3018 West Twenty-first place, Chicago. The machines are disassembled, cleaned and renewed, putting them in practically new condition. The service includes an engineering department, advice as to proper machines and mounting patterns.

Fig. 1—The secretary's office is in the center of a suite extending across one end of the second story

Modern Brass Shop Offers Contrasts to Old Type

BY PAT DWYER

FOUNDRIES devoted to the manufacture of light brass castings have shown less development during the past 50 years than other branches of the metal working industry. This is especially true of the physical equipment and of the building in which brass castings are made. Like every general rule, the foregoing presents many shining exceptions. Some foundries of this class are on a par in every detail of building, equipment and methods with anything in the industrial field. However, the greater number still lag behind the procession, due principally to the fact that little or no power equipment is required and any building with four walls and a roof that affords a reasonable measure of protection from the weather is considered ample for all practical purposes. Light, heat and ventilation are not regarded as major factors and smoke and gas fumes from the furnaces are excepted as natural phenomena; something that always existed and always will and therefore is beyond human control.

Many of these foundries start in a modest way with limited capital which precludes constructing expensive buildings. Something light and flimsy, or more frequently an old, second hand building is pressed into service and adapted to making castings. The adaptation usually consisting in installing one or more furnaces, a chimney and a few benches. In the event that the business increases a leanto is built on to the most convenient side and if necessary, other additions of a like character are placed in service later.

With a business established in this manner and returning a fair margin of profit, the owner or owners naturally hesitate to erect a new plant even though they are satisfied that lower production costs and larger output, due to improved conditions, soon will absorb the necessary expenditure. In other cases the business is established in a leased building and so long as conditions are fairly satisfactory the foundryman is content to drift along until it becomes imperative that he seek other quarters. He then is faced with the alternative of seeking other leased premises elsewhere, or erecting his own building. Usually by that time he has changed his mind about the inadvisability of providing a building specially designed for his requirements. Also by that time he is in a better position to consider with favor a proposition involving the erection of a new building.

Seek Architect's Advice

Conditions somewhat similar to those outlined in the preceding paragraph were responsible for the change recently made by the Sterling Brass Co., from its old location at 47th street and St. Clair avenue to 9600 St. Catherine avenue, Cleveland. The company specializes in plumber's brass fittings and in addition to the foundry where the castings are made, maintains a machine and finishing shop, polishing and plating departments where the material is assembled and prepared for shipment. In the old plant, due to changes and expansion, the succeeding operations from raw material to finished product did not follow each other in proper or orderly sequence, with the result that there was considerable lost motion and a correspondingly proportionate overhead expense. The furnaces were in the same room as the molding floors and contaminated the air with smoke and gas fumes. The roof was low with no adequate ventilation facilities and the windows were small and few, entailing an appreciable expense for artificial light.

Having definitely decided to erect a new plant particularly fitted to its needs and requirements, the company engaged the services of Allen Sogg, architect and engineer, Cleveland to prepare plans. The main features of the new plant, including the general layout insuring a steady flow of material from one end to the other, also the building material employed and style of construction, conform to accepted modern factory standards. However, many innovations, some original and others, adaptations, have been introduced and incorporated in the general scheme. The furnace room furnishes the most conspicuous, example of this character and will be considered more fully later.

The group of buildings is arranged in the form of the letter *U*. By referring to the illustration Fig. 2 it will be noted that the stock room, core room, pattern vault and furnace room are located in the left wing. The molding department occupies the cross bar and the right hand leg of the *U* embraces the machine and finishing shops, shipping room, office, etc. The left leg and the cross bar, each is a single story structure, but the right leg is two stories in height and at one end where the locker room and heating equipment are located in the basement, it is three stories high.

Wood block floors are laid throughout with the exception of those in the stock room and furnace room, which are concrete. The walls are of red brick, painted white on the interior of the various departments and the wood roof is supported on steel beams. A comprehensive sprinkler system in all departments is connected to the city water service. Steam heat distributed through wall radiators located in all departments is supplied by a boiler with a rated capacity of 14,000 square feet of radiation. Crude oil is employed for fuel under the boiler and also for other purposes throughout the plant including the core oven and the melting furnaces.

Acting on the generally accepted

modern theory that abundant light and adequate ventilation are real dividend builders through increased production and in reducing the percentage of spoiled work, the walls of the building with the exception of those inclosing the furnace room, are made up almost entirely of steel sash. This feature is illustrated clearly in Fig. 2 where the black areas represent the brick work.

Monorail Conveyor

Fresh air is introduced through swinging sections on the lower part of the sash in the foundry department and other swinging sections in the continuous sash on both sides of the Pond truss roof serve as an outlet for the contaminated air and for the comparatively small amount of steam generated during pouring and shaking out the castings.

The path of the monorail conveyor installed by the Cleveland Crane and Engineering Co., Wickliffe, O., is shown by the dotted line in Fig. 2. It will be noted that it begins at the receiving room at one end, passing through the furnace room, the foundry and machine shop to the shipping door. Immediately before it swings toward the shipping door it passes close to an elevator by which material is conveyed up to, and down from the second floor. From the foregoing it will be seen that there is a steady flow in one direction. The raw material enters at one end of the plant and moves steadily forward until it emerges in the shape of finished product at the other end.

Shipment of material both into and out of the plant is made by motor truck and therefore railroad accommodation is only a secondary consideration. The plant is built in a section of the city that insures an adequate labor supply of the type accustomed to the class of work handled. Nearly the entire operating force from the old plant have moved to the new one and it is claimed that marked increase of production has been secured, due to the improved layout and greater facilities afforded in the new plant as compared with the old. Heretofore, the employes have been paid on an hourly basis, but plans have been about completed to install a piece work system. This will yield a more intensive production from the same floor area and will not involve increasing the staff. Delays incident to moving and also a greater volume of orders than usual, have placed the company far behind in its deliveries.

Draft in Furnace Room

New molding sand and scrap metals are stored in the bins shown in Fig. 4 which is the receiving room shown in Fig. 2. A gyratory riddle made by the Great Western Mfg. Co., Leavenworth, Kans., is suspended from the monorail. This is employed to riddle the new sand into a wheelbarrow before it is taken to the molding floors. The scrap is graded carefully and kept in separated bins. Gates and sprues are collected in the cleaning room and used each day a they accumulate. Borings and turnings from the machine shop are collected in suitable containers and also returned to the furnace room daily.

An interior view of the furnace room is shown in Fig. 5 and a cross section of the building showing the roof contruction and ventilation detail is pre-

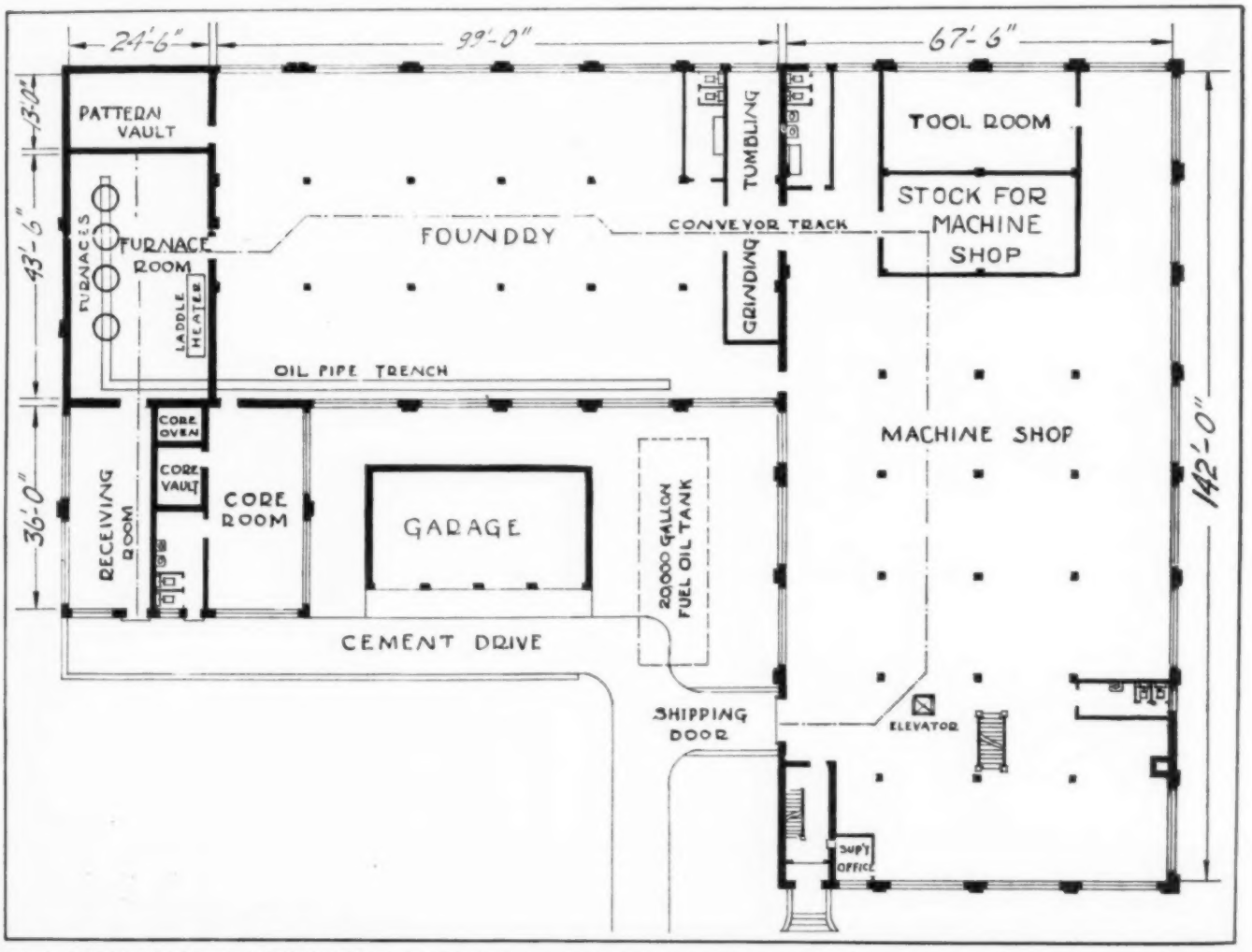


FIG. 2—FIRST FLOOR PLAN SHOWING LOCATION OF THE VARIOUS UNITS—THE DOTTED LINE INDICATES THE POSITION OF THE MONORAIL EXTENDING THROUGH ALL DEPARTMENTS

sented in Fig. 3. The building in effect practically is a chimney in which fresh air constantly is drawn in through a door leading to the receiving room, a second door communicating with the molding department and the three openings *A*, *B* and *C*, Fig. 5. The required area for these various openings was calculated according to standard formulas of chimney design. A swinging sash in the wall immediately below the roof furnishes an egress for smoke and hot air. In this instance theoretical anticipated results have been fully realized. The furnace room at all times is clear and free from smoke at least below the level of the furnaces. A certain amount of smoke inevitably is developed while the furnaces are in operation, but the constant draft carries it upward and out through the upper windows. What smoke is produced is confined within the four walls of the furnace room and none of it finds its way into the adjoining molding department.

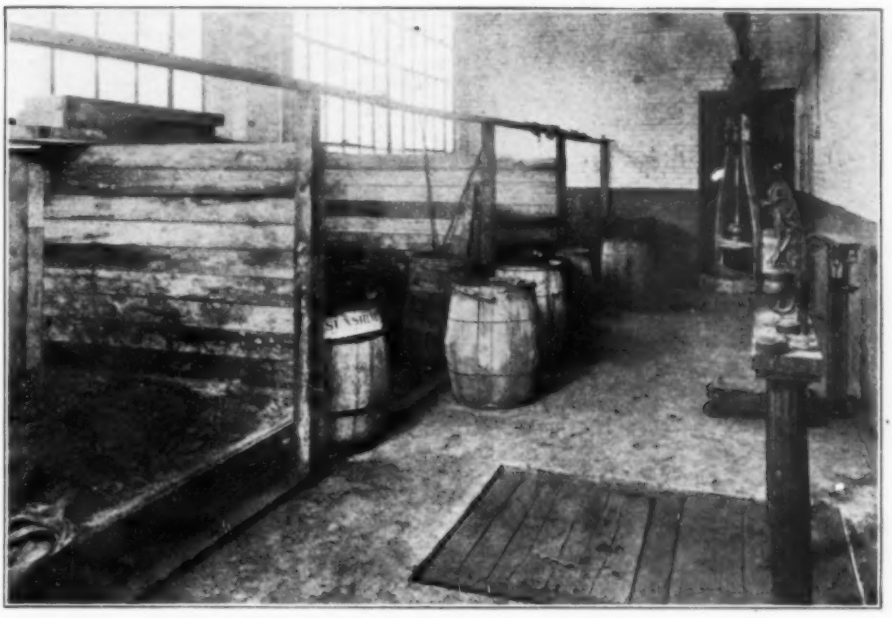


FIG. 4—SCRAP IS SORTED AND CLASSIFIED AND KEPT IN SEVERAL BINS CLOSE TO THE FURNACE ROOM

Melting Equipment

Metal is melted in a battery of four furnaces made by the Monarch Engineering & Mfg. Co., Baltimore. Two of the furnaces are the tilting, open flame type, with a capacity of 500 pounds each to a charge. The remaining two furnaces also are the tilting type, but they are equipped with crucibles for holding the metal. The entire battery is set up in a straight line spanning a trench in the floor containing the oil supply pipes. This feature is indicated clearly in Fig. 5. Oil is fed to the furnaces under pressure supplied by two tanks situated above the floor in the corner of the furnace room near the 20,000 gallon oil tank buried in the yard. A pump connected to the main line keeps the small tanks supplied and the volume of air compressed at the first filling supplies the necessary pressure, aided by gravity in forcing the oil through the furnace burners.

Air for each furnace is supplied by an individual fan made by the Buffalo Forge Co., Buffalo direct-connected to a 2-horsepower motor. The monorail is forked in the furnace room with a branch serving each pair of furnaces. A suitable floor controlled switching device shown at the upper right in Fig. 5 serves to direct the ladle carrier suspended from a chain block to any of the furnaces. The monorail is so arranged that the metal from the furnace may be poured directly into the crucible while the latter hangs suspended in the hoist.

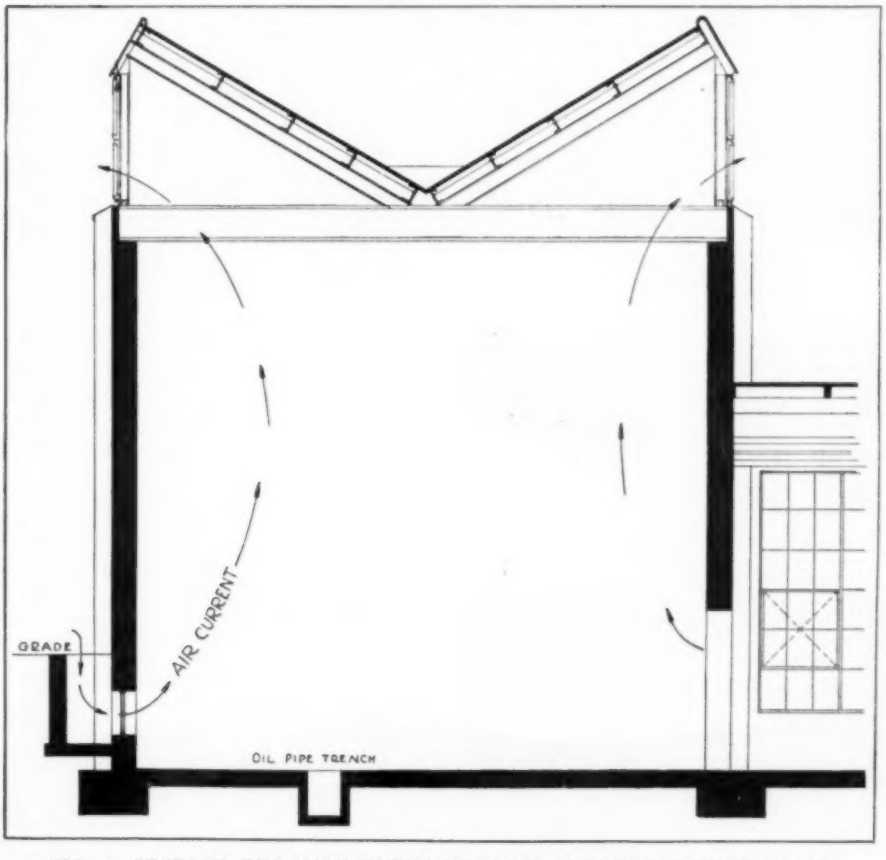


FIG. 3—SECTION THROUGH FURNACE ROOM SHOWING PRINCIPLE OF VENTILATION SYSTEM

Castings Must Be Exact

Small crucibles with a maximum capacity of 100 pounds of metal are employed in pouring the molds. The patterns, sometimes to the number of 50, are mounted on match plates and made in snap flasks, requiring in some cases not over 10 pounds of metal. The castings must conform to close specifications, color, weight, homogeneity, dimensions, etc., and must be poured at a practically uniform temperature. It has been found that about ten molds is the maximum that can be poured from one crucible while meeting the foregoing conditions. A sheet iron, rectangular frame, resting on the floor and provided on the top with a cover and on the bottom with an oil burner, is employed for heating the crucibles before they are filled with metal. The crucibles are heated to a bright red or to approximately 1300 degrees Fahr.

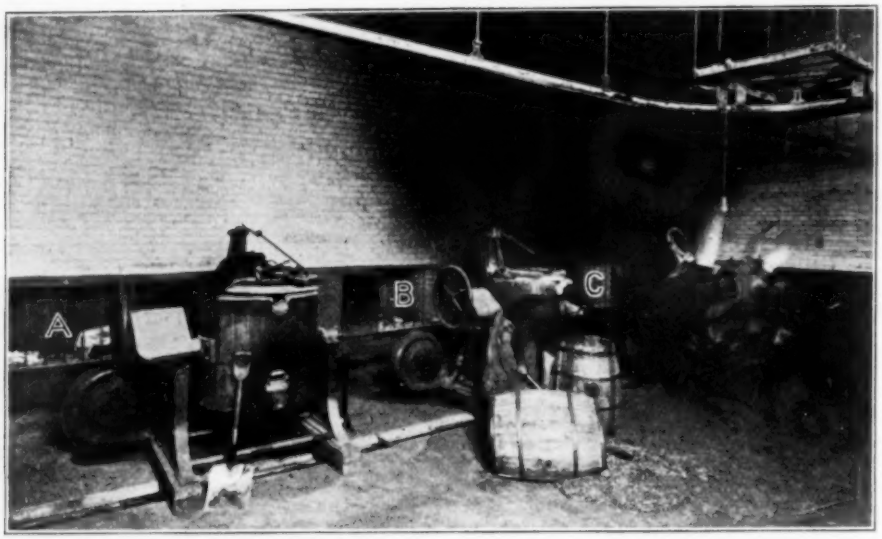


FIG. 5—THE BATTERY OF FOUR FURNACES IS SET UP IN A STRAIGHT LINE OVER A TRENCH IN THE FLOOR CONTAINING THE OIL SUPPLY PIPES

All the patterns with their respective matchplates and follow boards, while not in use in the foundry, are kept in a pattern storage vault occupying the extreme upper left hand corner of the building as it is shown in Fig. 2. Suitable shelves arranged in tiers are provided for storing the matchplates on edge where they readily may be slipped in and out. A small bull's eye light on the outside of the door frame is connected with the lights on the inside of the vault and serves as a reminder to shut off the lights when no person is inside. The layout of the foundry floor looking toward the machine shop is shown in Fig. 6.

Hand-power, squeezer machines of various makes are arranged along the walls on both sides close to the windows. The molds are made in snap flasks and stacked two deep on wooden pouring stands for pouring. Narrow steel bands, rammed up in the drag and pulled up across the joint after the mold is closed and the snap flask removed, serve as reinforcement to the body of sand while the mold is filling with metal. The patterns are comparatively shallow, extending but a short distance either into the drag or cope and therefore deep slip jackets are not required.

The interior of the core room in which girls are employed exclusively is shown in Fig. 7 and its position in regard to the remainder of the plant may be noted in Fig. 2. A row of benches extends along one side and one end in front of the windows. A seat is provided for each employe and also a stand for her supply of core plates. Many of the cores are placed directly on the plates, but others are transferred from the coreboxes to metal forms which support them while drying. The cores are dried in a drawer-type oven made by the Foundry Equipment Co., Cleveland. It is shown with the drawers extended in the left background, Fig. 7. Girls have their own entrance to the core room and do not come in contact with any of the other employes with the exception of one man detailed to load and unload the oven racks, keep the benches supplied with sand and plates and any other work of a like character required.

FIG. 7—A WOOD BLOCK FLOOR, WHITE PAINT AND LARGE WINDOWS ARE SOME OF THE AUXILIARY PRODUCTION FACTORS IN THIS GIRLS' CORE ROOM

FIG. 6—VARIOUS TYPES OF HAND POWER MOLDING MACHINES ARE INSTALLED ALONG BOTH SIDE WALLS

A rectangular steel, water tank is provided at the foot of each of the central columns for the convenience of the molders in wetting down their sand piles. The molds are dumped almost immedately after they are poured and the castings are dipped in the water tanks for the double purpose of cleaning and cooling them. The castings

then are piled in the central gangway and afterward taken to the cleaning and grinding room, a space partitioned off on both sides of the gangway between the foundry and machine shop. On one side of the gangway the castings are removed from the gates and rough ground, on the other side they are tumbled in a wet mill supplied by the W. W. Sly Mfg. Co., Cleveland. After they are cleaned they are taken to the machine shop and piled in a space partitioned off from the remainder of the floor for that purpose.

The machine shop 67 x 142 feet 6 inches, is equipped on the first floor with the necessary automatic and semi-automatic machine tools for finishing and testing the castings. Toilet facilities are provided at two diagonal corners to minimize lost time. A light elevator designed by the architect, and constructed and installed under his supervision, serves to convey the castings from the first to the second floor where the plating and polishing departments are located. A self acting switch automatically stops the motor when the cage arrives at the level of either floor, thus preventing accidents.

The general offices of the company extend all across the front end of the second story. That of the secretary, Miss E. M. Collins, is shown in Fig. 1. She has been with the company a number of years as purchasing agent and secretary.

The basement at the same end of the building is divided into two compartments. One as already stated contains the heating equipment. The other is fitted up with lockers for the men's clothing and with a row of wash stands. The employes enter through a hallway containing a time clock.

Finds Incentive Lacking in the Foundry

AT THE present time, one rarely can take up a technical periodical without noticing an article concerning the failure of the technically trained young man to follow up the foundry business. The writer has heard several prominent engineers speak on the scarcity of such men in the field and the rewards such a career offers in the way of advancement. Why do not more such men enter this field?

When a young man leaves a first class engineering school, he usually has the choice of three lines of activity. He may enter sales, production or take up manual work, including the foundry. The latter will lead to executive work as well as the others.

It is no secret that the majority of men have a preference for the first field. The foremost thought of the lad leaving college is, "Where can I earn my first million in the shortest possible time?" In his mind the answer comes, "In sales work—better pay."

Furthermore, who will dispute the assertion that there is more fascination here than in the other divisions, provided the man is gifted in this direction, although the young man seldom considers whether he is qualified. The trouble at the present time is too many men who are not fitted have elected sales work. Lastly, this field offers the student a chance to roam about more or less for a few years before settling down.

The second selection, where the young man enters some large company to learn the practical side of his theoretical education, is the popular second choice. Here he is still learning at a desk—rarely in the field. Often is tied down to this same desk in the general office for life. He is poorly paid and unless he has exceptional ability he will never rise from among the crowd. Yet here he has a position where he may wear his white shirt, and have his nails manicured weekly—facts heavily considered by the college man now.

Lastly we consider the field with the *great opportunities*. Let us follow through with this fortunate youngster his first days. Suppose for example that he starts in as the writer, *ramming up* on some of the larger flasks in the middle of the summer. Any man from four years devoted more or less to mental activity will find it quite a task to become acclimated to this purely manual labor. He will be transfering from brain labor to a purely monotonous physical task, requiring little or no mental work. On this floor of the shop the youngster will not be able to see the results derived from his work and may lose interest unless determined to see himself through this apprenticeship.

At present the average man in the shop is paid, roughly, 55c an hour and the student will be lucky indeed if he gets this to start. As a result, the man who is determined to follow this calling, no doubt, will have to sacrifice various more attractive offers in other lines while serving his time in the shop.

There is no better example of a pessimist than some foundry foreman under whom the boy will have to work: A man grown up in his narrow line—grown as sour as a lemon and as grouchy as a bull dog. Working under one of these kill joys is enough to send an ambitious young man into other lines.

All in all, the college man that enters the foundry field has picked no rosy path. To follow this course to the great opening, the lad will have to have a great liking for the work, with several years of hard manual labor among a class of men such as he probably has not known before.

If the foundry superintendents desire to get young men to enter this field, let them lighten the load as much as possible. Of course it is foolish to even think that these men can become experts without going through the actual work; but the work can be made more pleasant and lighter. However, the average boss has the idea that, "I started in shoveling sand and it is good enough for anyone else." This they will sooner or later find out is a mistaken idea. The student should be compelled to do this work only so long as it is instructive.

Keep the boys interested, give them some small responsibility, let them try some experimental work, and the ranks will be filling with technical men of high ability. For the other fields of engineering have found that it pays to get these men from school, give them some special work preparatory to securing important executive positions.

What He Thinks

WONDER what the other fellow thinks, is the fruitful source of interest to the average mortal. Witness the famous series of cartoons on the subject, considering the mental evolutions even of the inanimate golf ball, doormat, etc. The accompanying article is a cross section of the thought processes of the much discussed technical man who has entered the foundry, choosing it as his vocation and expecting to apply his educational advantages to aid in his success. Perhaps his experiences are unique; undoubtedly they are as relates to the temperament of his foremen, but nevertheless, he presents some problems the solution of which may aid in the vital question of developing skilled and educated men to handle the production phases of the industry. The writer is a thinker, he possesses ambition and a willing desire to work where the results of his efforts are in sight. In fact, he might be an asset to some foundry where his abilities might be developed through supplying incentives which apparently are few in the shop where he now is employed.

How and Why in Brass Founding

By Charles Vickers

Cannot Color Babbitt

In our work the question has arisen as to whether it is practicable to add an ingredient to babbitt which will produce a distinctive color, without affecting the physical characteristics of the babbitt.

We remember having seen lead base babbitts, or antifriction metals, carrying a faint tinge of pink, but are unable to state how the color was obtained. The supposition was that copper produced the color, but strange to relate there was no copper in that alloy. This color was faint and elusive, but it could be distinguished. The copper-tin-antimony series of babbitts—the so-called genuine babbitts—are often given a touch of gold color on the surface, which is produced by the bisulphide of tin formed by the use of sulphur as a flux with salammoniac, also by the introduction of an infinitely small amount of manganese which is oxidized. The presence of such a small amount of manganese that it could scarcely be found as a *trace* by the chemist will make it easy to get these colors on the top of the ingot when the alloy is poured cool, whereas minus the manganese, the alloy has to be poured quite hot to get the colors. These colors are only skin deep, but they are a talking point as they are popularly supposed to prove the presence of copper, at least we have heard salesmen make such statements, but the copper has nothing to do with it.

While it would be rash to make the flat statement that babbitt cannot be distinctively colored, we can state that so far no known means of doing it commercially has been found.

Melt Aluminum Turnings

We have some aluminum turnings to melt which when pigged analyze as follows; aluminum, 96.31 per cent; manganese, 1.01 per cent; iron, 2.41 per cent; silicon, 0.27 per cent. Can you advise how to use this metal to make an alloy similar to No. 12? Also we find a considerable amount of a dust-like dross is skimmed off from the melts into a pile, and in about two minutes this becomes incandescent. Is this dust an oxide of aluminum caused by improper melting, or is it due to some solution used in the machine shop in turning the metal?

To get an alloy like No. 12, using the metal of the analysis given in the query is a simple matter. Melt together 43 per cent of the ingot with 43 per cent of pure aluminum ingot and 14 per cent of a hardener composed of 50 per cent copper, 50 per cent aluminum. This will bring the iron down to close to 1 per cent, and the manganese to under 0.5 per cent. Also it will add 7 per cent copper. The silicon can be neglected.

The reaction of the skimmed dust is not due to any sulphur added to the aluminum by the cutting compounds used in the machine work. It is a reaction caused by the fixation of nitrogen by the heated alumina, or oxide of aluminum, in the skimmings. After the glowing mass has cooled, wet it with common lye water and the ammonia will come off voluminously. It is produced by the oxidation of the turnings in melting, and the reaction is promoted by the heat, exposure to air, the presence of carbon, and, most important of all, the presence of zinc chloride. That is, minus the zinc chloride, the reaction is not so likely to occur. This flux while ideal for molten aluminum, is not good for finely divided material; as it causes drossing. Technically barium chloride is much to be preferred and by its use as a flux on skimmings it is possible to melt them with a low loss.

Acid Dip for Coloring Brass Castings

Due to the fact that at times it is necessary to shake out castings before they have time to cool we get castings of all colors. Therefore, we would appreciate the formula for a dip or wash that will allow us to ship our castings all of one color.

It will be necessary to clean the castings of sand before immersing them in the dip in order to conserve the acids. The following dip is good for this purpose as it does not fume like the regular brass dips:

	Pounds
Sulphuric acid	10
Saltpeter	2
Water	5

First dissolve the saltpeter in the water in an earthernware crock; add 1 pound of the acid, pouring in a thin stream, stirring meanwhile with a piece of glass. This will heat the water and it is necessary to stop the addition of acid from time to time in order to allow the solution to cool and prevent it reaching a boiling temperature. For that reason the acid is added gradually and only a pound at a time. The solution should be prepared at night, and before morning it will be cold. Then, after the acid has been poured off the potassium sulphate that will be found in the bottom, it is ready for use. The castings are dipped for a few seconds, then are rinsed in running water. They will keep their color better if they are dried by dipping in hot water in which a little lime is dissolved. However, the use of acid dips for improving the color of brass is unsatisfactory as a general rule, being messy and expensive.

Cupola Not Ideal for Melting Brass

We desire to know if it is practical to melt brass for castings in a cupola. We have a certain amount of brass castings that we use in our work and would like to pour about a ton of metal at a time. Would this be practical, using a cupola of 24 inches in diameter? If it is practical, how should such a cupola be charged to get the best results?

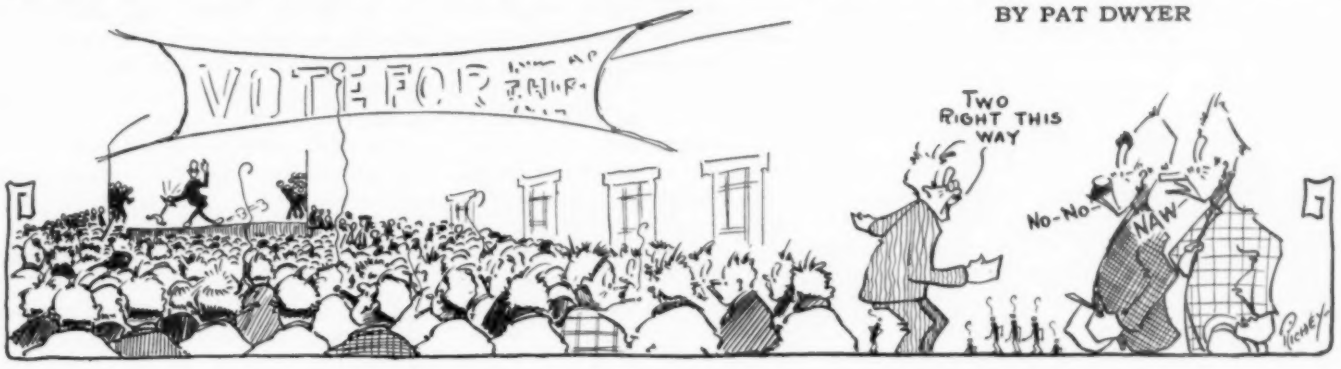
While a cupola is not an ideal melting furnace for brass it has been used successfully to melt both copper and alloys of copper. However, we gather from the query that it is hoped to make small castings from this cupola-melted metal, and if such is the case we doubt whether it can be done regularly and get the castings as good, or as cheaply as they could be purchased from a foundry specializing in such work.

Should it be thought advisable to experiment with the cupola, operate it the same as for melting cast iron. Get the copper or brass melted down and away from the contamination of the fuel as quickly as possible, then tap into an exceedingly hot ladle covering the metal with charcoal. The molds being ready the brass can be carried off like iron and poured. Molten brass or bronze gets viscid and sticky as it cools, and strings from the lip of the pouring vessel. It must be poured hot enough to avoid this, otherwise the castings will be of no use.

It probably would pay to install a small tilting brass melting furnace, either gas or oil-fired, and reserve the cupola for melting iron exclusively. The fuel used in the cupola will carry away considerable brass, especially zinc which oxidizes and volatalizes readily. In addition it is easy to aerate the metal in a cupola, which produces spongy castings.

Bill Learns a Little About Politics

BY PAT DWYER



PUBLIC spirited gentlemen animated by the most pure, patriotic and unselfish motives and with a sincere desire to do honor to other gentlemen who later may be in a position to dispense patronage, a process technically known, I believe, as juggling the pork barrel, have conducted a series of public meetings recently to which every free and independent voter has been invited. According to announcements published in the papers and others distributed with a lavish hand in the shape of hand bills or circulars, talented orators peculiarly well qualified to discuss the burning questions of the day were to address the meetings and show in unqualified terms and without peradventure of a doubt that certain sterling patriots were willing to forego their own private interests for the honor and privilege of accepting elective office in the gift of and at the hands of the sovereign people.

Accounts of the meetings appeared in the papers on the following days and the average citizen gathered that (a) the meeting was a perfect frost, slimly attended by a few die-hards, wedded to their idols, or (b) the hall was packed to suffocation by an enthusiastic audience which wildly applauded every telling hit made by the speaker of the evening.

In the first case the paper directed attention to the fact that the lack of attendance pointed unmistakably to the fact that the great intelligent public no longer could be fooled with cant and hypocrisy and remembered, only too distinctly, the long list of broken promises. In the second case the paper directed attention proudly to the fact that an enlightened public opinion knew how to distinguish the true from the false and the meeting confidently could be accepted as an infallible indication of a perfect landslide and an overwhelming majority for the party at the forthcoming election. Naturally, in the face of such conflicting evidence, and further, owing to the fact that none of the candidates was known to me personally I welcomed Bill's suggestion that we attend a meeting held recently in our neighborhood. Personally I did not anticipate any great measure of enlightment and I felt that my party affiliation would not be seriously jeopardized, but I had the usual curiosity to hear the various arguments presented and also, since I had not attended one of these rallies for many years, I wanted to compare the technique with that prevailing at the meetings with which I at one time had been familiar.

A third reason is that I always have had a weakness for listening to public speakers, whether the orator has been perched on a soap box on a street corner or on a public platform in more pretentious surroundings. Indeed if I was pinned in a corner and forced to express an honest-to goodness, bedrock opinion I think that after due consideration I would have to admit that the soap-box boys have created the more favorable impression.

This necessarily does not mean that I always have agreed with their sentiments or subscribed to their doctrines, but the same mental reservation holds true with the other class of speakers.

The street corner orator is a fluent and rapid-fire artist, not afraid to drop occasionally into the vernacular or, if necessary, to use a slang expression to make a point. He has the happy gift of being able to think on his feet and his impromptu interpolations add a zest to his remarks, sadly lacking in more formal speeches. He has to depend on his personality and method of address to hold his audience. Invariably he gives the impression of sincerity, of his faith in and enthusiasm for the importance of his message, the true and twin foundations on which all successful public speaking is based.

Contrast this with the dry matter-of-fact speech with which you probably are familiar, where the speaker drones along with many an *er* and *Ah* for an hour and where good form and common politeness are all that hold a bored and yawning audience to its welcome conclusion. Yes sir! It may be that I will be charged with having a depraved taste. In fact I have been accused along that line on several occasions by a lady friend of mine whom oxen and wain ropes would not have held an instant on a corner to hear the most eloquent and flowery flights of oratory. I have missed many a treat on that account. However, the fact remains as I have stated and probably is owing to what the aforesaid lady has been pleased to describe as "the nature of the beast."

On the night of the meeting Bill and I found ourselves with about 300 other enthusiastic citizens packed into a hall belonging to a fraternal organization that has a membership of probably 200 and an average attendance of 24, including the officers. Spectators were standing in the aisles, at the back and draped along the side walls. In a word, and without reference to Mr. Hoyle, it was a full house.

The chairman rapped for order several times, was deeply grateful to note from the attendance that the people were taking a real, active interest in electing their representatives, and confidently looked forward to seeing the entire slate triumphantly swept into office on the rising and irresistible tide of popular approval. They all knew the object of the meeting, to put the seal of their approval, in

THE QUESTION IS: WHICH WAY WILL HE GO?

a manner of speaking, on the various standard bearers of the party and therefore he would not take up any more of their time but would proceed at once to introduce the speakers of the evening. However, although he was perfectly confident that the result of the election would be overwhelmingly in their favor, still he wished to sound a word of warning based on the proverb with which of course they were more or less familiar. He did not need to say that he had reference to the saying "Do not count your chickens before they are hatched."

He regretted the necessity of directing their attention to the fact that the other party—he would not dignify it by the name of a once honorable party of which it was only the washed out remains—was stooping to and employing the most disgraceful tactics in its frantic efforts to make a showing at the polls. He implored them to be on their guard, to treat with silent contempt any overtures on the part of the opposition and above all things to let nothing stop them from casting their ballot, the token, sign and emblem of a free people, on election day. He fully realized that the gentleman whom he was to have the honor of introducing, in a moment, was probably the best informed man, he would not say not only in the state but in the entire country, on the science of government and its application to federal, state and local affairs. He knew that the large and intelligent audience in front of him had a comprehensive grasp of the subject, but he could guarantee that his friend—and he was proud to call him friend—would touch on some points hitherto only known to the elect. Information of the class referred to by the man in the street—if they kindly would overlook his use of the term—as inside stuff.

After a few concluding remarks in which he touched briefly on Paul Revere, Valley Forge and the Minute Men of Lexington, he warned his hearers that the country once more is on the verge of a crisis and it behooved them as thinking men, as earnest men, as men who are as proud and jealous of their country's honor and good name as they are of their own, to rally to the booths on election day and vote for the man who now was about to address them.

Just about the time I had decided that this was going to be an all-night session and that the chairman had sized us up as a bunch of owls, he reluctantly stopped the motor and shut off the wind. He did not stop abruptly, but coasted along on his own momentum long enough to quote those memorable and appropriate lines from the poet—the name escaped him for the moment.

"Strike—for your altars and your fires!
Strike—for the green graves of your sires!
God—and your native land!"

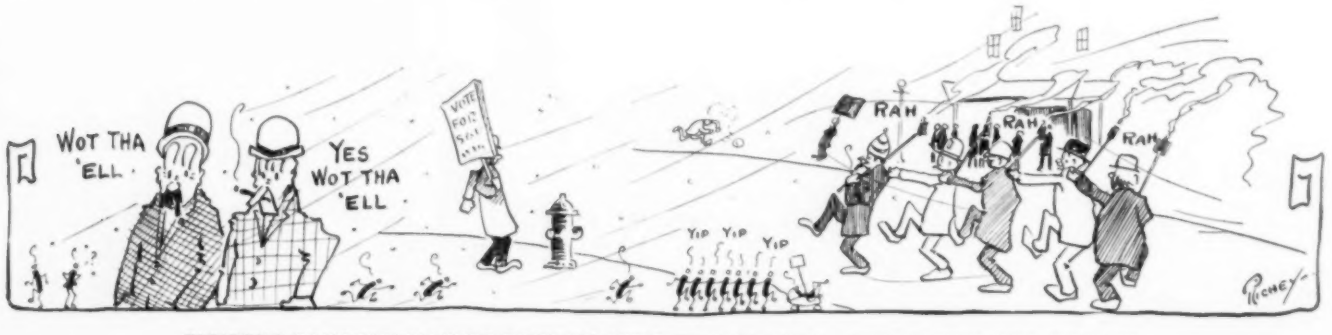
WHEN THE FIGURES BEGIN, BILL DECIDES TO MOVE

He would leave that thought with them. Principally in a figurative sense but he had no hesitation in assuring them that unless each and every one did his duty and exercised his franchise on the day of election, it would not be long until the words would have to be taken in their stark, staring and literal significance. Gentlemen, he considered it an honor and a pleasure to have the privilege of introducing—and by the way, he knew that every man present would be intensely interested in the vital message which the speaker was about to deliver—our next senator, the man qualified by natural gift, training and experience to represent this important state in the senate chamber of the United States. Gentlemen! Our next senator, the honorable W. K. Alsoran.

Apparently the crowd was 100 per cent for the candidate for they rose to their feet with one accord as the speaker stepped forward on the platform. Led by a leather lunged citizen who demanded in a loud voice to know what was the matter with the honorable W. K., the crowd lifted its collective voice jubilantly and loudly to the effect that he was all right and when to make assurance doubly sure the leather lunged lad again came to the front, solo, and asked them definitely and pointedly "Who's allright?" the chorus came back in musical cadence "W. K. Alsoran!"

Quiet finally was restored and the candidate was afforded an opportunity to deliver the burning message foretold by the chairman. He bowed several times while the ovation was at its height. He expressed his pleasure at having the opportunity of discussing some of the principal issues of the campaign before such a representative audience. As a plain man, one of the people, a man who knew what it was to feel the honest sweat dripping off his brow, he could sympathize with their aims and aspirations and realized to the full the honor conferred upon him when he had been selected to carry out their wishes during the forthcoming term. When he had been notified, much to his surprise, of his nomination, he had taken the question under serious consideration, knowing full well that so many other men in the party were better qualified for the position and at first had felt inclined to decline the honor. He was quite aware of his own limitations, none better, but when he had been assured that the position entailed many sacrifices, he felt it his duty, as one who had the welfare of the nation at heart, to accept and do what little lay in his power to perpetuate the grand old traditions of the party in conducting a clean administration.

He traced the progress of the country for the past 100 years and quoted statistics to prove that we had advanced by leaps and bounds while his party had been in power. We had stood still and in many cases actually retrograded during



CITIZENS ROUGHLY MAY BE DIVIDED INTO TWO CLASSES. WHICH ONE ARE YOU IN?

those periods when the spineless opposition had by malice and underhand methods temporarily usurped the reins of government. Westward the star of empire had its way and whereas 100 years ago the center of population was situated near the Atlantic seaboard, it now was several miles west of the Mississippi, the father of waters and with its tributaries the second longest river in the world.

He deplored the everlasting conflict between capital and labor and placed the blame directly on the party with whom he was proud to say he never had, and never expected to have, anything in common. This despicable party, he regretted to say, fostered and kept the strife alive merely as a political weapon to further its own nefarious ends. He had no intention of saying anything that might be construed as a reflection on his opponent's character, but he was surprised to find him in such a camp and supporting the doctrines of a notoriously corrupt and inefficient party.

For himself, personally, and he was only echoing the sentiments of his own party, he stood four square and absolutely in favor of the square deal. The laborer was worthy of his hire and capital was entitled to a fair return on its investment.

"Come on," said Bill at this point. "Let's go. He is going to open his political blunderbuss and shoot statistics for the next hour. If he would flay the everlasting hide off his enemies, throw a generous measure of vitriol, boiling pitch and brimstone into his talk I could stand for it; but these long dreary flocks of figures turn my stomach. It is just about as interesting as to have some person read aloud from a telephone directory, and just about as illuminating. The fact that we imported 10,000,000 green hides from the Argentine last year as compared with 9,999,999 the year before, conveys nothing tangible to my mind, except perhaps that the checker may have skipped one in his count. I cannot get a thrill out of the information that mouse traps now are made in Germany for $1.00 per thousand and that the specific duty has been changed to *ad valorem*. I know that they still may be had at the old price in the 5 and 10-cent stores.

"A recapitulation of the national debt of the United Sattes at the close of the last fiscal year, compared with like figures compiled at ten year intervals over the past 50 years, leaves me cold and the same is true when I am told that if all the wealth in the country was divided on a pro rata basis, my share would be $58.76. It may be there, but apparently the distributing system is not functioning smoothly."

"It seems to me," I said "that the whole situation is summed up rather neatly in the text: Hebrews XIII, 8."

Bill, with his usual contrariness, objected to the reference, but admitted that in a pinch the quotation might be applied in the manner I had indicated.

"Whether the quotation applies or not" he said, "I have no doubt that the practices and methods connected with elections are the same now as they were 2000 years ago. Man is a creature of habit, he hates changes and innovations and has a natural bent to follow the line of least resistance. He arrives at a goal in some haphazard way and then continues to follow the same path, sometimes for generations, in preference to seeking a short cut. If some daring character throws tradition in the discard and strikes out along new lines, he is regarded as mentally unbalanced, a dangerous character upsetting the established order and the public considers it is doing a meritorious act when it places as many obstacles as possible in his path.

"Thirty years ago an almost universal belief obtained among foundrymen that the time a cupola could be kept in blast depended on the diameter. Tables were published in books appearing at that time showing the melting capacity of cupolas. Not the melting capacity per hour but the total amount any given size cupola would melt before it choked up. The fact that cupolas, small as well as large, can be operated continuously all day long, if necessary, is demonstrated in many foundries every day, and yet it is surprising to find the number of foundrymen who cling to the old belief and claim that it cannot be done. Their particular furnace invariably chokes before the heat is finished and they look upon it as something over which they have no control. The idea of investigating the process as practised elsewhere never seems to occur to them."

"Well;" I said "what are you going to do about it?"

"Nothing." said Bill. "Nothing, my boy. The way of the transgressor may be hard; but it is not a circumstance on the flinty road traversed by a person who attempts to come between a man and his settled convictions. The reformer always draws a larger share of brickbats than bouquets and therefore I cheerfully can subscribe to the sentiments expressed by Service's *Volunteer* under somewhat similar circumstances: 'Wot the 'ell Bill! Wot the 'ell? ' "

Japanese Slacken Work

The Japanese government foundry at Yawata, northern Kyushu, has been compelled to reduce operations two-thirds because of drought the worst in 70 years. Vice Consul Currell, at Nagasaki, has advised the department of commerce.

Piston Rings Are Faulty

Question—We recently have been making quite a number of individual piston rings with which we are having trouble. We are buying what we believe is the best grade of pig iron, and using absolutely no scrap castings in our mixture. Only a small percentage of the sprues are put back in the heats again. The patterns are mounted on aluminum plates, and the molds are made from a fine Albany sand. Until a few days ago we had the best of results, but since then have run into some trouble and have had rejections as high as 40 per cent due to little black spots in the iron and also to hardness.

The pig iron analysis, as given us by the furnace is as follows:

	Per cent
Silicon	3.00
Sulphur	0.018
Phosphorus	0.70
Manganese	0.57

In making up the heat we put 1125 pounds of coke on the bed then 1000 pounds of iron, 300 pounds of coke, 1000 pounds of iron, 150 pounds of coke and so on. We are using on each charge 700 pounds pig iron and 300 pounds of our own sprues with absolutely no scrap castings.

Answer—So far as we can see by what you say of your process, there are few changes to recommend. There is no reason why more coke should be put on the first charge than on the following charges. The bed should be high enough so that when the first charge is melted, only as much coke is required to replace the burned coke as will be required after the other charges.

Of course, we cannot tell how much silicon and manganese are burned out in melting but we should judge that the silicon and manganese in your pig iron are a trifle low. The silicon in the piston ring should not be below 2.75 per cent and the manganese at least 0.5 per cent. If the manganese is low, you should secure pig iron with a higher percentage of manganese or add pea-size 80-per cent ferromanganese in the ladle. If the silicon is low, the use of a pig iron with a higher percentage of silicon would be desirable.

Trouble is sometimes encountered by oxidation of the iron in melting due to too sharp a blast or too little coke. Evidently, you are putting enough coke between charges and should not have trouble with this if there is coke enough on the bed. The only way you can safely control this work is to have frequent analyses made of your finished castings.

The Monarch Foundry Co., Detroit, has filed a petition in bankruptcy. The property is for sale.

Powdered Coal for Malleable-II

Calculating Gas Velocity, Volume and Length of Time in Furnace—Application to Annealing Ovens—Carbon-Dioxide Recorder Used To Automatically Signal Stoppage of Coal

BY T. W. ATTERBURY

IN A powdered-coal furnace while burning the same weight of coal per minute as on the hand-fired furnace the volume of the gases of combustion produced is less. If the same gas velocity is to be maintained, it is necessary to increase the weight of coal burned per minute, thus increasing the B.t.u. content of the gases, increasing the furnace temperature and speeding up the furnace.

The difference in gas volume by the two methods of firing is due to the fact that in powdered coal little excess air must be heated, whereas in hand firing the air and coal mixing is imperfect and a large amount of excess air is required over the amount actually necessary for combustion. A velocity of 100 feet per second was found to give the best results. The area required to give this velocity may be calculated as follows:

With a gas temperature of 2600 degrees Fahr. at the throat the volume of 1 pound of gas of average composition at 2600 degrees is 75 cubic feet. The volume of gases produced in burning 40 pounds of coal per minute, allowing 13 pounds of air per pound of coal, therefore, is 40 x 13 x 75 = 39,000 cubic feet per minute. Our formula can be stated thus:

$$\text{Area of throat} = \frac{\text{Total cu. ft. of gases per min.}}{\text{Velocity per minute}}$$

$$\text{or } \frac{39{,}000}{100 \times 60} = 6.5 \text{ square feet}$$

With the charge down and fluid, the velocity of gases at the first tap hole should be known. Our experience has shown that a velocity of 31 feet per second, under these conditions, gives good results.

Assume the gas temperature to be 2850 degrees Fahr. and the furnace burning 40 pounds of coal per minute. The volume of 1 pound of gas at this temperature is 81 cubic feet. The cross sectional area of the furnace at this point is 22.5 square feet above the metal line. The volume of gases produced per minute under these conditions, allowing 13 pounds of air per pound of coal, is 40 x 13 x 81, or 42,120 cubic feet per minute.

The formula can be stated thus:

$$\text{Velocity per sec.} = \frac{\text{Total cu. ft. of gases per sec.}}{\text{Cross sectional area in sq. ft.}}$$

$$\text{or } \frac{42{,}120}{60 \times 22.5} = 31.2 \text{ feet per second.}$$

To calculate how long the furnace gases stay in the furnace, our formula can be stated as follows:

$$\text{Number of seconds gases stay in the furnace} = \frac{\text{Total cubic contents of furnace}}{\text{Total cu. ft. of gases per second produced}}$$

From Fig. 5 the cubic contents of the furnace are estimated as 560 cubic feet.

The total cubic feet of gases is obtained from the example just given, thus:

$$\frac{42{,}120}{60} = 702 \text{ cubic feet per second}$$

$$\text{Number of seconds} = \frac{560}{702} \text{ or nearly } 0.8$$

That is, the gases in the furnace are completely changed every 0.8 second.

When burning 35 pounds of coal per minute the volume of gases would be less and the rate of volume gas travel would be slowed down to 0.91 second. On a 25-ton furnace with the charge down, and melting proceeding at a maximum rate, the gas velocities as calculated have given excellent results.

The closer the furnace can be run to theoretical proportions the higher will be the flame temperature, assuming that the coal and air are both fed uniformly and perfectly mixed before entering the furnace. The theoretical amount of air will depend somewhat on the composition of the coal, but ordinarily will run about 150 cubic feet of free air per pound of coal; 25 per cent excess air would be 187.5 cubic feet per pound. Good practice will lie between these two points.

The total volume of air required is obtained as follows: 40 pounds of coal per minute and 187.5 cubic feet of free air per minute gives a fan capacity of 40 x 187.5 = 7500 cubic feet per minute. For a 25-ton furnace a fan capacity of 8500 cubic feet of free air per minute will meet all requirements.

The air pressure at the fan is usually about 12 to 14 inches of water and the issuing air and coal pressure at the burner mouth is usually about 5/16 inch of water. The drop in pressure between the fan and the burner is due to a gradually increasing area of the feeder pipes and to friction losses.

On an air furnace the air for combustion is usually all put through the

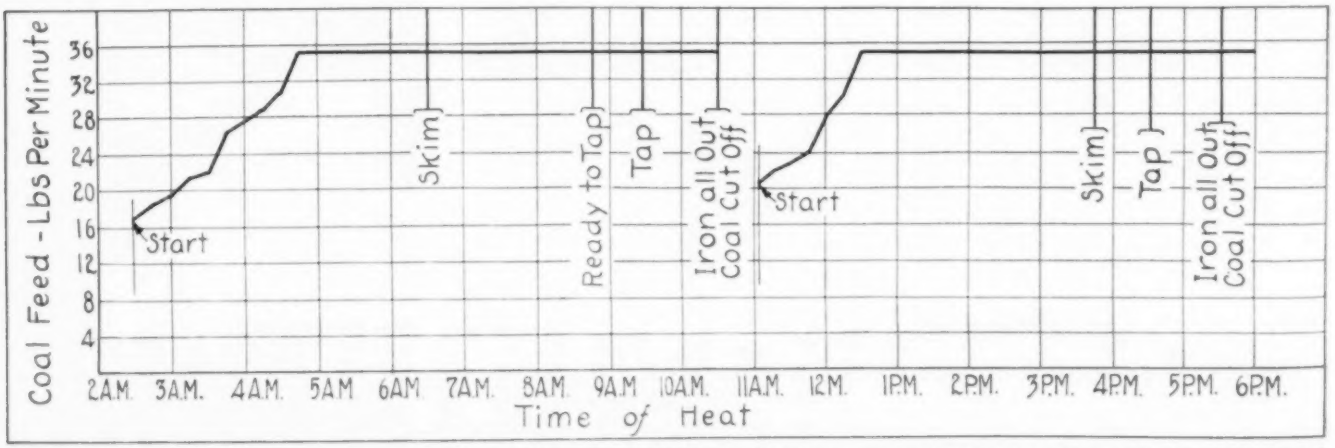


FIG. 9—CURVE AT THE LEFT—COAL FIRED, POUNDS PER MINUTE, DURING THE MORNING HEAT—FIG. 10—CURVE AT THE RIGHT—COMPARATIVE FIGURES FOR THE AFTERNOON HEAT

burner thoroughly mixed with the coal, no secondary air being drawn into the furnace from the atmosphere. The reasons for this are, first, the furnace being operated under a slight pressure, atmospheric air cannot be drawn in; second, better mixing, better control, and more complete combustion can be obtained by feeding the coal and air through the same burner; third, it gives less danger of oxidizing the charge.

Large Combustion Chambers

In boiler practice the rate of combustion and combustion space is of first importance, and the boiler furnace is usually enlarged for powdered coal so as to burn at the rate of between ½ to 2 pounds of coal per cubic foot of combustion space per hour. Good results are obtained in air furnace practice when burning at the rate of 3 to 4 pounds of coal per cubic foot of total furnace volume, and ordinarily it has not been found necessary to provide a large combustion chamber. That increased combustion space would result in increased efficiency of combustion is evident when comparing the flue gas analysis from an air furnace with that from a large muffle type annealing oven. In the former the carbon dioxide percentage will average 15 per cent while in the latter 19 per cent can be obtained. In the annealing oven referred to the rate of combustion is 0.65 pounds of coal per cubic foot of combustion space.

To drive the fan supplying combustion air, and the mechanism for the coal feeders usually will require 4 kilowatts per ton capacity of the furnace, assuming the furnace operating at capacity.

The curves, Figs. 9 and 10, show how the rate of coal feed on 26-ton heat, Fig. 9 the morning and Fig. 10 the afternoon heat. These curves also show the time taken to make the heat. A comparison of the furnace charge by percentage is given, the same furnace being used. The charge is usually 26 tons when firing with pulverized coal, while the hand-fired charge was 20 tons. These charges are made up as follows:

	Pulverized coal	Hand fired
Pig iron	44	48
Hard scrap	30	36
Malleable scrap	18	9
Steel	8	7
	100	100

It may be noticed that the percentage of hard scrap used on the pulverized-coal furnace is less. This is accounted for because less hard scrap is made when firing with powdered coal. The increased malleable iron scrap used is largely purchased scrap.

Application of powdered coal to annealing ovens is similar to that described for the melting furnaces, the equipment, however, being of smaller capacity. A good sized storage bin is desirable, and besides this a coal feeder, mixers or carbureters, and a fan for combustion air complete the equipment. The first cost of this equipment is relatively low.

Compared with hand firing, the labor cost is low. One man can take care of 29 large ovens. A saving also is made in coal consumption, while the repair costs are quite low. Also, flexibility is obtained as the coal burned can be varied at will and the fire can be started and stopped instantly to give the desired muffle temperature at different stages of the anneal.

As in any pulverized coal installation, the coal feeders are of first importance. In a large muffle type oven of 75 ton capacity, where the combustion space over the muffle is large, any feeder which will inject a mixture of coal and air will burn and produce heat. However, a comparison of different types of feeders will show a marked difference in results. A good method of making this comparison is by the use of a carbon dioxide recorder, taking a continuous sample of gas at the stack base. A good feeder will produce a curve which is almost a straight line, showing uniformity of feed, which is conducive to high temperature and high efficiency of combustion. Also the percentage of carbon dioxide will be high and 18 per cent to 19 per cent of this gas has been maintained for long periods with a good type of feeder. A poor feeder will produce a curve which is wavy, showing at times marked irregularities; the carbon dioxide percentage will vary and at times be quite low, showing a low efficiency of combustion.

This point is illustrated by Figs. 11 and 12. Fig. 11 showing the results obtained from a good feeder, and Fig. 12 giving the results of a poor feeder.

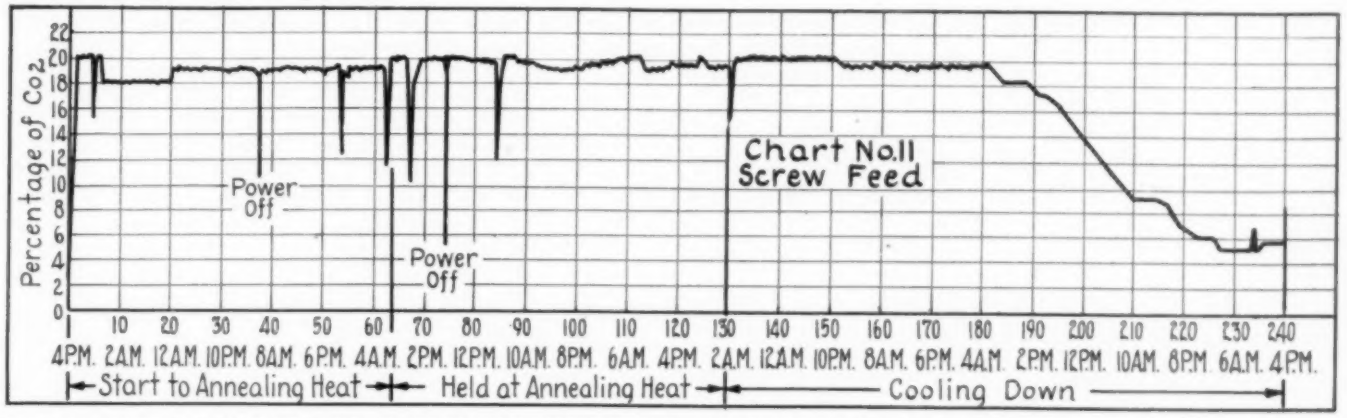


FIG. 11—CARBON-DIOXIDE CURVE FROM AN ANNEALING FURNACE BURNING POWDERED COAL INTRODUCED BY SCREW FEED

These tests were taken over the full heat or a period of 240 hours, as shown on the charts. The shaded portion of the curves covers the time the coal feed was on and the portion not shaded covers the time the coal feed was stopped. These curves were taken from a muffle type annealing oven of 75 tons capacity and represent average every-day practice on this type of oven.

Curves Check Firing Operations

By the use of such curves a check can be made on the firing operations; for instance, on Fig. 12 a sudden drop of the CO_2 percentage would indicate a stoppage of the coal supply, thus giving warning to the fireman that something was wrong with the coal feed. This sudden drop of CO_2 can be made to sound an alarm automatically, thus warning the fireman who may be attending to another oven some distance away.

Most coal feeders consist of a screw of horizontal or vertical design, running at a variable speed and delivering a constant weight of coal each

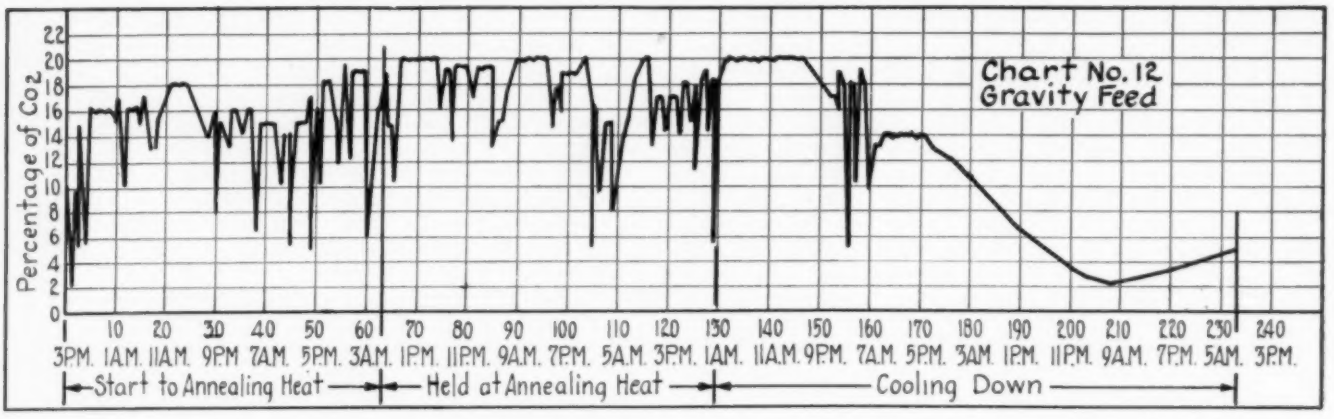

Percentage of Co2
Chart No. 12
Gravity Feed
3P.M. 1A.M. 11A.M. 9P.M. 7A.M. 5P.M. 3A.M. 1P.M. 11P.M. 9A.M. 7P.M. 5A.M. 3P.M. 1A.M. 11A.M. 9P.M. 7A.M. 5P.M. 3AM. 1P.M. 11P.M. 9A.M. 7P.M. 5AM. 3P.M.
Start to Annealing Heat
Held at Annealing Heat
Cooling Down

FIG. 12—CARBON-DIOXIDE CURVE FROM AN ANNEALING FURNACE BURNING POWDERED COAL INTRODUCED BY GRAVITY FEED

revolution. This variable speed may be obtained by a mechanical speed change device, or by a variable speed motor and rheostat hand control. Usually the mechanical control is more reliable and will require less attention.

For a 75-ton muffle type oven the maximum coal consumption is 10 pounds of coal per minute. During the holding period, this amount of coal is ample, but during the firing up period when opportunity is had to make time, this amount of coal feed could be increased to advantage. With ovens as at present designed it is difficult to increase the coal feed during the firing-up period. By the use of a supplementary burner and a rearrangement of flues, it should be possible to burn additional coal at this period and cut down the time appreciably.

It is desirable to operate with a minimum of excess air to avoid oxidizing or scaling the iron. The amount could be kept down to about 150 cubic feet of free air per minute with a good type of mixer and burner.

The correct fan volume and pressure can be determined as follows: With a coal consumption of 10 pounds per minute and allowing 160 cubic feet of free air per pound of coal, the fan capacity required will be 10 x 160 = 1600 cubic feet of free air per minute. A fan of 1800 cubic feet per minute capacity and about 4 ounce pressure will be suitable for the 75-ton oven we have selected as an example. The air pressure as issuing from the burner will under these conditions be about 0.6 inch of water. The pressure in the combustion chamber and muffle will vary from 0.04 to 0.4 inch of water, depending on the stack damper setting.

Get Efficiency of Combustion

Combustion space is usually large, and with an oven 40 feet long, similar to the 75-ton muffle type we are figuring on, no difficulty is encountered in getting nearly theoretical efficiency of combustion. The size of the firebox is important and it is advisable to make this of as generous proportions as space will permit, to avoid slagging troubles. A small firebox will localize the heat and soften the firebrick, causing some unburned coal to get into the slag, which is indicated by a black color. The slag accumulation due to melted firebrick, ash and unburned coal will collect at the bottom of the firebox, necessitating a cleanout every 12 hours and delaying the firing. With a firebox of proper size, no cleanout is necessary during the heat, which is a saving of time and labor.

Operation is simple. A wood fire is usually made in the firebox at the start to promote combustion of the powdered coal, and when the firebrick is hot, the fan air is turned on and then the coal screw is started, the coal feed being regulated to give a good flame condition in the firebox with a slightly hazy smoke issuing from the stack.

With the pyrometer installation for recording muffle temperature, and the use of a carbon dioxide recorder taking a sample of gas from the base of the stack, the gas condition in the muffle can be regulated so as to avoid scaling the iron and to permit the coal to be burned with a maximum efficiency and temperature of combustion. It must be remembered that the muffle is not sealed perfectly and gases of combustion leak through from the combustion space surrounding it. As the gas pressure in the muffle chamber has been shown on numerous tests to be from 3/10 to 6/10 inch of water it can readily be seen that gases must be penetrating through from the combustion chamber. These gases upon analysis showed practically no oxygen, being composed of carbon monoxide, carbon dioxide and nitrogen.

Automatic Check Advantageous

Without the use of a carbon dioxide recorder the operation is entirely a matter of judgment on the part of the foreman. It is well to have an automatic check on the performance if maximum results are to be obtained. The author has seen an oven with the coal supply shut off for a long period; particularly during the night shift when on occasions the coal supply has

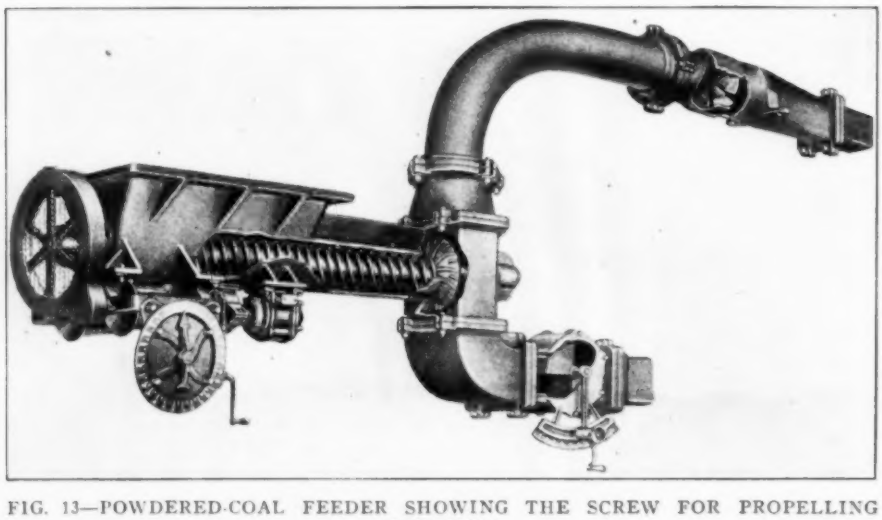


FIG. 13—POWDERED-COAL FEEDER SHOWING THE SCREW FOR PROPELLING THE FUEL

been shut off for an hour and the fan permitted to run during this time, simply blowing in cold air, cooling off the oven and oxidizing the charge. This has occurred on an oven with a poor design of bin and feeding equipment, making this unit unreliable in operation.

The advantages of a carbon-dioxide recorder are that it:

Sounds an alarm when coal feed stops.

Gives fireman a check on combustion at any time.

Enables fireman to secure maximum combustion efficiency and save coal.

Less ash is deposited in the oven, due to better combustion.

Permits superintendent to check whether coal feed has been regular.

Shows whether an oven is leaky during holding and cooling down period.

The flame temperatures can be maintained at a maximum with powdered coal. The temperature in the firebox is usually around 2750 degrees Fahr.; in the combustion chamber 40 feet from firebox and before entering the flues is 2000 degrees, then passing through the flues the full length under the floor it cools to about 1250 degrees by the time it enters the stack.

A great amount of heat is carried off and lost by the gases as they pass up the stack, but this appears to be unavoidable with present design of ovens. Since the hot gases must be at a higher temperature than the maximum temperature of the charge to be heated, in order to give up heat to the charge, it is evident that these gases must leave the furnace at a high temperature.

The combustion chamber and flues must be cleaned at the end of each heat. Ash from the coal is deposited in the form of a light spongy mass clinging to the brickwork like moss, and is easily scraped off. The dust deposit is less than with hand firing and is more easily removed.

Power consumption is low, consisting of a small constant speed motor driving the fan, and a small variable speed motor with rheostat control driving the coal-feed screw. A single motor can be used, having a mechanical speed changing device operating the coal feed screw. The total current consumption by screw feed ovens is about 6.8 kilowatt hours per ton annealed.

If the same coal is used as for firing the air furnace, it should screen about 80 to 85 per cent through a 200-mesh screen. This will work satisfactorily although a tendency to localize the heat in the firebox is found owing to complete combustion taking place at the mouth of the burner. A better distribution of heat throughout the oven is obtained by using coal of a coarser mesh, if available, say 70 to 75 per cent through a 200-mesh screen. This permits complete combustion to be delayed until the gas travel has reached a point one-third to one-half the length of the combustion chamber. The zone of combustion can be regulated somewhat by the shape of the issuing flame, producing a long or short flame as desired. In the air furnace a short flame is necessary, while in the annealing oven a long flame is preferable.

It is advisable not to leave more coal in the bin at the end of the heat than is necessary. Not that it is dangerous, but that on account of the coal absorbing moisture during a shut down of several weeks it is sometimes difficult to start up quickly, owing to the damp coal arching in the bin or choking up the feed screw. Should a fire be accidentally started in a storage bin, it may smolder several days before being discovered. When the fire is located, the best thing to do is to start the equipment and feed the coal into the oven, burning it. If the storage bin is sealed as far as possible, not permitting any movement of air through it, little possibility of fire is present owing to lack of oxygen to promote combustion.

Fire rarely occurs in the coal bins and when it does usually is due to carelessness in operating the coal dryer. Should the fire run several days without being discovered, some coke will be formed in the bin, which may

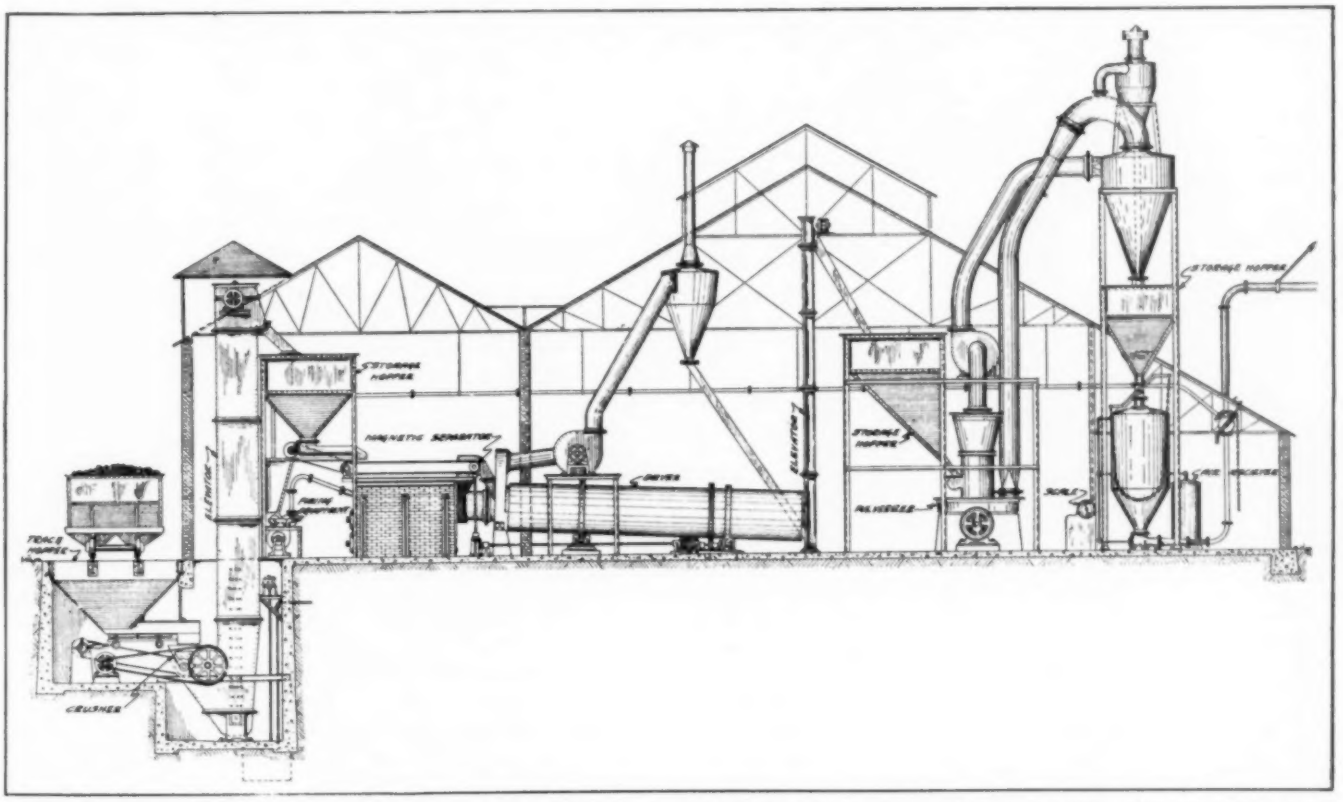


FIG. 14—IN THE TYPICAL INSTALLATION FOR BURNING POWDERED COAL THE COAL IS DRIED, PULVERIZED, CONVEYED AND BURNED WITHOUT MANUAL LABOR

give trouble with the feed screw. In such case it is necessary to remove the obstruction.

It is customary to prepare the coal in a central pulverizing plant, and convey it in the dried, powdered form to the furnace bin or point of use. The equipment required is drying apparatus, pulverizing mill, conveying apparatus and feeding apparatus, Fig. 13, and bins for storage of raw coal, dried coal and powdered coal. A flow sheet showing the movement of the coal from the car to the furnace bin is shown by Fig. 14.

Two forms of mills have been used generally, one known as a quick-running mill, used in many installations in this country; and a slow-working mill not used much in America but used extensively in Europe.

On a tonnage basis, the low-speed mill has a slight advantage owing to its being built in larger units than the high-speed mill. Maximum tonnage of high-speed mills, as built, is 6 to 8 tons per hour, while slow-speed mills are built up to 15 tons per hour.

Maintenance cost of the mill per ton of coal pulverized was found to be as follows:

High-speed mill	$0.04
Self-contained unit	0.10
Slow speed ball and tube mill	0.30

Common practice in the distribution of powdered coal can be divided into four main groups as follows:

Screw conveyors, suitable for short distances.

Compressed air transport, where the coal is drawn from storage into weighting tanks and then blown through a pipe 4 or 5 inches diameter to the point of use. This system will transport a distance of several thousand feet without difficulty. It has a large tonnage capacity and will convey at the rate of from 30 to 60 tons per hour, the air consumption being relatively small, and the system possessing much flexibility.

A screw pump running at a high rate of speed feeds coal into a 4 or 5 inch diameter pipe line, the coal being mixed with a small quantity of compressed air to make it more fluid and to reduce friction. This system transports coal 1000 feet or more.

Air mixture system in which the coal is mixed with a considerable portion of low pressure air, the mixture being circulated in a loop by means of a fan, coal being taken from the loop where wanted.

It is difficult to give accurate figures on the cost of installing a coal pulverizing plant as each installation is designed to suit local needs. This may vary from as low as $350.00 per ton capacity in the largest plants to more than $1800.00 per ton capacity in plants as low as 20 tons capacity.

A figure for the cost of pulverizing coal per ton cannot be stated even approximately without knowing the local conditions. The author knows of plants where it is costing over $2.00 per ton to prepare the coal for malleable iron work. This is too high and may be accounted for to some extent from the fact that the plants are operating at a tonnage much less than the rated capacity. A recent job, on which the author estimated, cost less than 50 cents per ton to prepare the coal. This included a charge of 15 per cent for interest and depreciation. The whole equipment of pulverizing and burning was under one roof. About 140 tons of coal per day was pulverized.

Preparation and Analysis of Silica Sand

Question: We have a large silica sand deposit on our property and should appreciate some information on how it is prepared for commercial use and also what is the usual silica content of sand used in foundries.

Answer: Three methods usually are employed in the initial preparation of silica sand for foundry use. The final steps in the process are the same in all three cases and the method employed at first depends on the source of sand supply.

In the first instance the sand is found lying in a loose pile and it only is necessary to pass it through certain sized screens to render it fit for use. Some of the grades employed for sand blasting and core making are dried before they are shipped.

In the second instance the sand deposit is found in a solid mass. The grains of sand are not united firmly enough to constitute a rock and yet they are united too closely to permit of digging the material and handling it as in the first instance cited. It is broken down and disintegrated by a powerful stream of water directed against it from a hose in the same manner that hydraulic mining is carried on. The resulting mass of water and sand is passed through a number of suitable screens which separate the material into varying degrees of fineness. It finally is dried, stored and shipped.

The third method for preparing silica sand probably is the most difficulty and elaborate of the three. In this instance the material is found in solid rock formation and has to be quarried and blasted out by explosives. The material is loaded on cars and taken to a gyratory rock crusher which reduces it to egg size. From the crusher it goes to a set of revolving cage drums which act as disintegrators and break the lumps up into the grains. This method is employed in preference to a rolling stroy the sharp corners and edges of the grains.

From the disintegrators the sand is conveyed by a belt and bucket elevator to the top of a high tower from which it passes by gravity through a number of revolving screens. The screens separate it into various sizes for commercial use, from the coarse lumps used in concrete road building, etc., to the finest grade of sand used in imparting a matt finish by the sand blasting process.

The fine sand and also all that intended for sandblasting purposes is passed through a suitable type of kiln which thoroughly expels all moisture. This variety of sand is loaded either directly into covered cars and shipped or stored in a dry room where it will absorb no moisture. The coarser grades of sand and those intended for use as molding sand are piled in the open air. A steam shovel or a locomotive crane equipped with a clam shell bucket is employed to load the sand into open top cars for transportation.

Open Commercial Testing Laboratories

Frank C. Tuttle Jr. and H. W. Highriter have opened commercial testing laboratories at 19 Congress Ave., New Haven, Conn. Mr. Tuttle graduated from Yale in 1916, after which he was for three years assistant research engineer under W. R. Bean of the Eastern Malleable Iron Co. For the last three years Mr. Tuttle has been assistant superintendent of the Naugatuck plant of the Eastern Malleable Iron Co. Mr. Highriter graduated from Tufts college in 1918, and has been with the Eastern Malleable Iron Co. ever since, having taken the position of assistant research engineer on Mr. Tuttle's transfer to the Naugatuck plant.

To Manufacture Hardware Specialties

The Philipp Mfg. Co., Easthampton, Mass., inaugurated operations recently for the manufacture of hardware specialties. R. Philipp, president and treasurer of the company, formerly was factory manager and production manager for 15 years with the Coburn Trolley Track Mfg. Co., Holyoke, Mass.

The Mid-West Mfg. Co. bought at sheriff sale the entire plant formerly owned by the Nebraska Foundry & Mfg. Co., and will manufacture their own product and also will de some job work.

MICROSCOPY OF CAST IRON

By J. W. Bolton

Types of Microscopes—Metallurgical microscopes are of the vertical and the inverted types. The inverted type is the most convenient, and best adapted to handling metallurgical specimens. In this type the movable stage is above the inverted objective. The body tube connecting with the camera is horizontal. The observation tube is fitted at an angle of 90 degrees to the body tube. In this type the specimen needs only one plane face and no special mounting to get the plane of the specimen face at right angles to the optical axis. The observation tube is located conveniently. The camera, being horizontal, is easier to manipulate and there is less chance for vibration.

The vertical type resembles the ordinary compound microscope except that its stage is movable vertically, and light is obtained by means of a vertical illuminator. It is possible to do good work on this type of instrument, but more care and time is needed than is necessary with the inverted type. Either type should be equipped with a good mechanical stage.

Objectives and Oculars—A microscope can be no better than its lenses. The two types of objectives commonly used in photomicrography are the achromats and apochromats. The achromatic objectives give a flat field but the higher powers do not show the fine details. Apochromatic objectives resolve well, giving clear, distinct images, but the field is not entirely flat. Achromatic objectives are to be preferred for moderate magnifications. For magnifications of 500 diameters or over the greater clearness of details given by the apochromatic objectives generally more than compensates for lack of flatness at the edges of the field. Descriptions of other types of objectives, such as fluorite objectives, aplanic objectives, micro Tessars, etc., may be found in dealers' catalogs.

Huygenian eyepieces are used with achromatic objectives, and compensating eyepieces must be used for apochromatic objectives. Beside flatness of field and resolving power, objectives for metallurgical work should be chosen to give the largest field of the object desired in as far as is compatible with good reproductions. Also, the objectives chosen should have the greatest possible working distance and, of course, be corrected for uncovered objects.

The author is chemical engineer, the Niles Tool Works Co., Hamilton, O.

(*Continued on Data Sheet No.* 452)

MICROSCOPY OF CAST IRON

(*Continued from Data Sheet No.* 451)

Reflectors for Vertical Illumination—The plane glass illuminator, the totally reflecting prism, and the totally reflecting semicircular mirror are the most commonly used reflectors. The plane glass illuminator is best for all around work, and especially for higher magnifications since it helps give finer detail and is more easily adjusted. The other types give a more brilliant image, with a slight relief effect, and require less time for exposure in photomicrography.

Illuminants—Photomicrography requires a much more powerful light source than visual examination does. The 4½ ampere carbon arc is most commonly used in photomicrography. Care must be taken to insure steadiness of the point of illumination. Direct current is preferable, as there is less flickering of the light. Rheostats are furnished for both 110 and 220-volt circuits. Among other photomicrographic light sources is the tungsten arc lamp. This lamp furnishes a concentrated light source (not as powerful as the carbon arc) which is steady and may be centered accurately.

The 6-volt concentrated filament tungsten lamp is satisfactory for visual examination. The light from either arc lamp can be cut down by means of the iris diaphrams, ground glass screens, etc., until not too powerful for visual examination.

Stand—The stand must be rigid. Vibration will make it impossible to obtain good results. The stand should be chosen with reference to its laboratory location and to its convenience. If there is vibration in the laboratory a special stand must be used.

Polishing Apparatus—Generally speaking the author finds it preferable to have grinding wheels mounted with faces vertical, while polishing cloths have been found most convenient when mounted horizontally.

Manipulations

Sampling—This requires judgment, because the sample must be *representative*. In gray iron the structure varies according to the size of the section and the depth at which the sample is taken. In sampling for general structure two or three blocks should be taken, and as much of a surface included as is possible.

(*Continued on Data Sheet No.* 453)

Note—This sheet may be cut into two sections 5 x 7 inches, and may be readily bound in note book form.

THE FOUNDRY DATA SHEET, NOVEMBER 1, 1922
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Study Core Oven Loss--II

Data on Baking Results Enable the Foundryman To Calculate Fuel Costs and Compare Electric with Other Heating Systems Based on the Cost of Fuels in His Locality

BY C. F. MAYER

FOR all practical purposes, other conditions remaining the same, a temperature difference of 10 degrees Fahr. would not necessarily result in a great variaiton in fuel consumption, so if we may compare the results approximately on a percentage basis, it is seen that the oil oven, compared with the electric oven with 4-inch wall as 100 per cent efficient, had a corresponding efficiency of 54 per cent. The electric oven with a 2-inch wall in this sense was 77 per cent efficient. These values are applicable with ventilation at a minimum for the electric ovens.

The preceding efficiencies compare as follows:

	With ventilation Per cent	Minimum ventilation Per cent	Difference Per cent
Oven A =	50	77	27
Oven B =	77	100	23
Oven C =	30	54	24

In the cases illustrated the small increase in ventilation apparently decreased the heat efficiency about 25 per cent; consequently it is exceedingly important to choose an amount of ventilation not in excess of the requirements.

In the case of the oil oven it was found that the recirculation principle is impractical due to difficulty with the burners and smoking, and it was probably due to the fact that a small amount of ventilation was present that the attempt was successful to a certain degree.

Figs. 14, 15, 16 and 17 represent a number of typical bakes produced by the electric and oil ovens. A final summation of the bakes are recorded in Table II. Our effort in obtaining the best representative bake in each instance was reduced, after some experimentation, to allowing the attendant to apply his own judgement, to a large extent gained from comparatively long contact with the ovens. This method is well illustrated in the curves and was found to be, as close as could be ascertained, the most reliable and effective means possible with the present installation.

In Fig. 14, the curve obtained from bake No. 12, indicates that the oven was heated initially from room temperature to 475 degrees Fahr. and allowed to come to uniform heat at 400 degrees. This procedure was carried out as indicated for four reasons: First to obtain a uniform starting basis; second, because 400 degrees was assumed the most desirable baking temperature; third, to allow an intelligent investigation of the heat required for baking purposes; and fourth, due to delay in racks being loaded with cores.

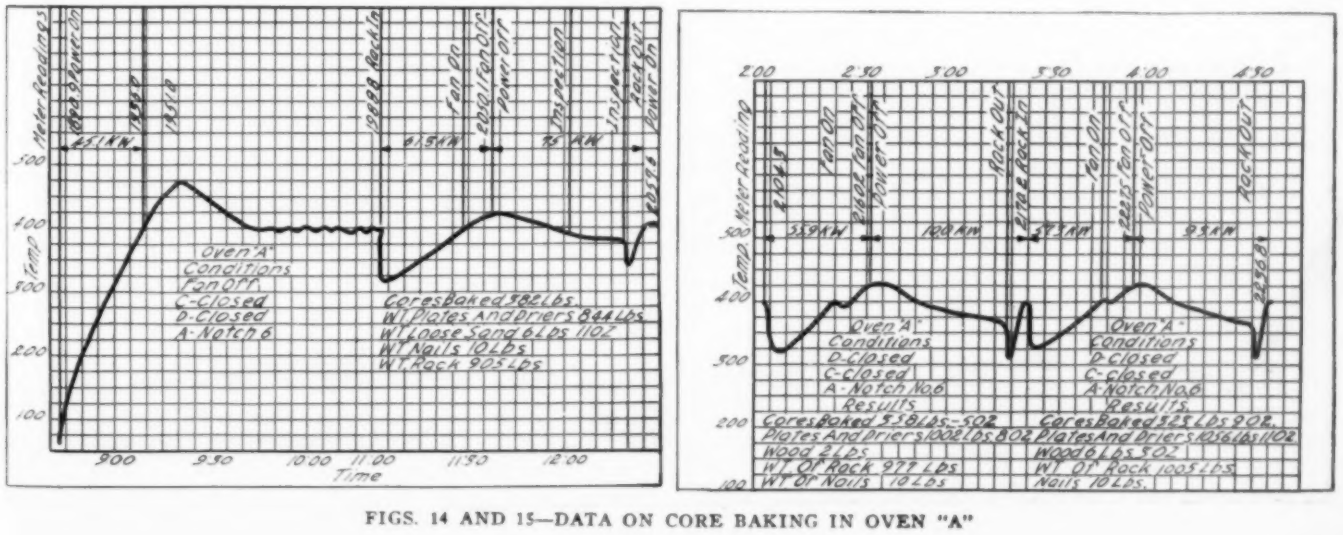
A rack of cores was loaded in at 400 degrees, consuming a varying amount of time from 25 to 60 seconds to move in, remove the elevating truck and shut the doors as indicated in Fig. 14. A resulting temperature drop occurred in each instance of approximately 80 degrees, the drop terminating in the neighborhood of 320 degrees. This drop was overcome in about 25 minutes of power application. During this period the ventilation condition was assumed the same as for determining the radiation losses, namely, fan off and dampers closed. At the point where 400 degrees was again reached a pungent baking odor was noticeable, indicating that the baking process was well under way. The fan was started at this point. When a temperature of 425 degrees was reached, both the fan and power were shut off and the temperature again descended gradually, as the process of absorption and radiation continued. Several inspections of the cores during the final soaking determined the time for removal of the cores. These inspections affected the temperature only slightly.

Removal of the rack and cores resulted in a temperature drop similar in nature to the loading drop, the most prominent difference being the rapidity in reaching the normal temperature again.

It may be particularly noted that the condition for each bake was made nearly the same insofar as the loading temperature, removal temperature, and time for discontinuing fan and power service, are concerned. Consequently the true amount of power for each bake could be closely ascertained.

Relative to the preceding paragraphs, it must be kept in mind that temperature drops and power requirements depend entirely on the nature and size of the load, a variation of which will produce similar variations in time for temperature recovery and power consumption. The consistency of the results, in cases illustrated here, indicate that the total loadings were quite uniform for most cases and in conformance with this foundry's standard practice.

Bakes 21, 22 (Fig. 16) and 27, using



FIGS. 14 AND 15—DATA ON CORE BAKING IN OVEN "A"

Table II

Baking Results in 3 Different Ovens

Bake number	Length of bake, minutes	K. W. power on, minutes	K.W. power used during bake	Fan on, minutes	Temperature, rack in	Temperature, rack out	Temperature, fan on	Temperature, fan off	Total pounds cores	Number o cores	Total pounds iron	Pounds cores per K. W.	Total weight per K. W.	Pounds cores per gallon	Cost per 1000 pounds cores
							Oven A								
12	82	39	68.8	10	400	375	400	425	382	....	1759	5.5	31.1	....	$5.46
13	80	37	65.9	11	400	...	400	425	358	1438	1989	5.4	35.6	....	5.56
14	77	37.5	66.6	9.5	400	...	400	425	324	1768	2072	4.9	35.9	....	6.12
							Oven B								
21	75	37	59.1	Off	400	370	400	425	304	1280	2084	5.2	40.4	....	5.77
22	69	37	57.9	10	400	380	400	425	244	1277	2023	4.2	39.1	....	7.15
27	74	34	60.0	9	400	..	400	425	298	....	2014	5.0	38.5	....	5.99
							Oven C								
29	80	31	2.621	28	350	400	350	455	297	288	2374	2.6*	....	113.0	.71
30	91	38	3.0	35	400	...	310	450	373	....	1996	2.87	....	113.3	.64
31	73	38	2.97	38	410	..	410	450	217	....	2164	1.7	....	73.0	1.10

Note: Pound per kilowatt (Equivalent). Assumption: 18,500 B.t.u. per pound oil; 3,412 B.t.u. per kilowatt; and 8 pounds per gallon.

the electric oven with a 4-inch wall, were conducted in a manner similar to the preceding ones, with a possible exception. Bakes 21 and 22 were conducted with the fan on and damper *A* set for notch No. 1 (exhausting). Bake No. 27 was conducted in a manner similar to bakes 12, 13 and 14. The curves possess the same characteristics as those of preceding bakes.

Oil Oven Bakes

As with the preceding ovens the general characteristics of the baking ovens were similar in respect to the electric ovens. However, at various periods during some of the bakes, difficulty was experienced with the burner operation, which caused a slight deviation from the generally smooth characteristics. Table II illustrates three typical bakes and Fig. 18, showing bake No. 29, conveys the nature of progress. It may be noted that the tendency for the oil oven, after the burners are turned off, is to retain its heat more tenaciously than the electric ovens. The curve continues quite horizontally to the completion of the bake with no drop to 400 degrees until removed. This difference in characteristic is undoubtedly due to the heat absorbed by the brick conbustion chambers and its effect was consistent for each bake.

The average bakes have been indicated for ovens *A*, *B* and *C* for comparison. The oil consumption for oven *C* also is put in equivalent form as kilowatt consumption.

Of particular interest is the time required for baking purposes, relative to cores of the type mentioned in Table III. The data clearly show that the time of bake, the power consumption and weight of material are directly dependent on one another. An increase or decrease in length of bake is due to an increase or decrease in weight of material or heat, and a like increase or decrease in power or fuel consumption follows. With operating conditions remaining a constant these facts are of great importance in the calculation of proper heating equipment.

It is peculiar but entirely plausible that although oven *B* proved to be the more efficient from a radiation standpoint, it actually baked less pounds of cores per kilowatt than oven *A* with a 2-inch wall.

Several Examples

Much has been said about actual electric corebaking capacity being in the neighborhood of 12 pounds per kilowatt, yet we find actually in this case it was 5 pounds per kilowatt. If the various construction features in and about the oven are carefully analyzed and the figures noted elsewhere in this paper studied, the reasons are apparent for this result. Several concrete examples serve admirably to illustrate the sources of dissipation.

Oven *A*, Bake 12 (Fig. 14)

(1) Radiation losses (400 degrees door temperature assumed) kilowatts

$$K = 25.2 \times \frac{82}{60} = 34.50$$

(2) Heating Racks, plates, driers, etc.

$$Q = \frac{S \times W \times (T_1 \times T_2)}{3412} = \frac{.115 \times 1759 \times \left[\frac{400+375}{2} - 65\right]}{3412} = 19.15$$

(3) Heating Air (Fan on 10 minutes)

$$Q = (33.4 - 25.2) \times \frac{10}{60} = 1.37$$

Power loss — 55.02
Total power used — 68.8

Useful power to bake cores 13.78

It is assumed that the final temperature of the entire mass is an average of the initial and final baking temperatures.

Oven *B*, Bake 22 (Fig. 16)

(1) Radiation losses (400 degrees door temperature assumed) kilowatts

$$K = 21.0 \times \frac{69}{60} = 24.20$$

Table III

Description of Cores

Description of core	Sand type	Core weight ounces
1½-inch, No. 3 check body	C	17.2
½-inch J. D. side angle body	B	2.04
¼-inch No. 2 globe body	Special	0.64
2-inch special J. D. globe C. piece	C	7.21
2-inch std. J. D. globe C piece	C	11.29
1¼-inch std. J. D. globe C. piece	C	1.93
2-inch std. J. D. globe C. piece	C	3.56
Feeder clamp	A	1.14
1¼-inch J. D. std. globe C. piece	C	5.42
2-inch J. D. std. globe body	C	27.08
1¼-inch special gate bodies	B	7.0
¾-inch J. D. std. angle body	C	1.27
Type C trolley splicer	A	2.90
Special Clark splicer	A	3.46
Clark splicer	A	3.03
Type D splicer	B	4.4
½-inch, No. 2 vertical check body	C	2.48
1-inch special gate body	B	4.38
2-inch J. D. std. globe body	C	
2-inch J. D. special globe body	B	30.0
2-inch J. D. special globe body	B	42.5
Trolley wheel		16.5

A—Sand = 60 parts by volume.
40 parts sand blast dust.
3 parts linseed oil.

B—Sand = 80 parts sand.
20 parts sand blast dust.
3 parts linseed oil.

C—Sand = 50 parts sand.
10 parts crushed cores.
40 parts molding sand.
3 parts linseed oil.
5 parts glutrin.

(2) Heating Racks, plates, driers, etc.

$$Q=\frac{S\times W\times(T_1-T_2)}{3412}=$$

$$\frac{.115\times 2023\times\left[\frac{400+380}{2}-65\right]}{3412}=22.10$$

(3) Heating air (Fan on 10 minutes)

$$Q=(27.4-21.0)\times\frac{10}{60}=\frac{1.06}{}$$

Power loss — 47.36
Power used — 57.90

Useful power to bake cores 10.54

In the first illustration of the distribution of power we find that 50 per cent of the total power used was lost in radiation; 27.8 per cent lost in heating the racks, plates and driers; and 2 per cent in ventilation. Only 20.2 per cent of the power consumed actually was useful. The oven efficiency might be stated as: $\frac{\text{Useful input } 1378}{\text{Total input } 68.8}$ = or 20.2 per cent.

Similarly for oven *B*, 41.7 per cent of the total power used was lost in radiation, 38.2 per cent was lost in heating the racks, plates and driers, and 1.80 per cent in ventilation. Only 18.3 per cent of the power used actually was useful. The oven in this case would be 18.3 per cent efficient.

A brief comparison of the average fuel cost per thousand pounds of cores is made in Table II, assuming a price for oil as 8 cents a gallon and power as 3 cents per kilowatt. Then the following would be the cost per thousand pounds of cores:

Oven *A* (Electric) $5.76.
Oven *B* (Electric) $6.39.
Oven *C* (Oil) $0.815.

These relative values vary with fluctuations in fuel prices but may, nevertheless, be assumed as a general indication of their comparative status.

The more important conclusions drawn from the preceding observations may be summed up as follows:

As indicated by the formulas and examples, a basis for determination of the heating requirements is available. Scientific rather than hit or miss measures should be adopted in oven designs, although the available data are somewhat meager and perhaps imperfect at present.

The formula "H_t"$=\Sigma(Q+K)$, forms a basis for heat calculation.

Ventilation, in core baking, serves three ends:

In a baking capacity (to furnish oxygen)
For combustion (oxygen)
For ventilation (to remove fumes and moisture)

Usually the first item receives its requirements if the last item is fulfilled. The second item is necessary for ovens using fuels other than electricity. From the results observed it is quite evident that minimum ventilation, or just a sufficient amount to fulfill the requirements, is desirable, and excesses should be guarded against. The problem of ventilation lies probably in the difficulty in obtaining the correct amount. This is quite easily solved by furnishing a sufficient quantity, determined principally from past experience, and, by a judicious use of dampers. The effects of minimum and greater than minimum ventilation have been illustrated as decidedly favorable to a minimum quantity.

The greatest source of heat loss is indirectly attributed to radiation. However, this loss is really an aggregate of innumerable indeterminable heat dissipations, among which may be included sources of loss through lack of air tightness, through metal (often unavoidable), losses at the doors, uninsulated floors, etc. Evidence that this point of view is correctly taken is illustrated graphically in Fig. 18. These curves show the relative effect of a practical test as compared with tests conducted by the writer on insulated boxes under ideal conditions. For example, with ideal conditions the box with a 2-inch insulated wall loses 65 B.t.u. per square foot per hour with a temperature difference of 335 degrees Fahr. from inside air to outside air. On the other hand, oven *A*, as tested under practical conditions, lost 300 B.t.u. per square foot per hour, a loss 362 per cent greater than the ideal.

Transmission Losses Indicated

Similarly, for an ideal test box, using an insulating material presumably of the same nature and thickness as that used in oven *B*, a loss of only 35 B.t.u. per square foot per hour was observed. The transmission loss for oven *B*, was in the neighborhood of 234 B.t.u. per square foot per hour, 570 per cent greater than the ideal condition. The theory advanced regarding the reasons for the degree of separation of the practical and the ideal conditions is further strengthened by the trend of the two sets of curves. Note that the curves for the practical condition and the ideal condition have an evident relation to each other. Fig. 18 also indicates the transmission losses for several other familiar oven materials, tested under ideal conditions.

An increase in the thickness of insulation, greater than 4 inches, might possibly increase the general efficiency, but this is questionable inasmuch as an efficiency increase after a 4-inch insulation is reached, becomes comparatively small and the cost relatively great. Emphasis is more essential on care in eliminating avoidable losses. Good conductors of heat should never be sanctioned for oven flooring or combustion chambers if economy in operation is a primary desire.

Perhaps 99 per cent of the foundrymen never stop to realize the tremendous bearing the weight of a core rack or truck, together with the plates and driers, has on their oven fuel bills at the end of a year. The results of the preceding tests have shown that from 25

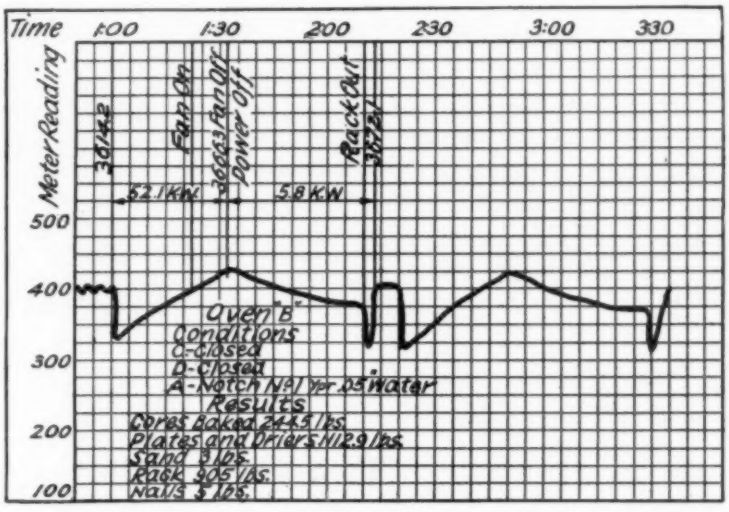


FIG. 16—RESULTS OF TEST ON CORE BAKING IN OVEN "B"

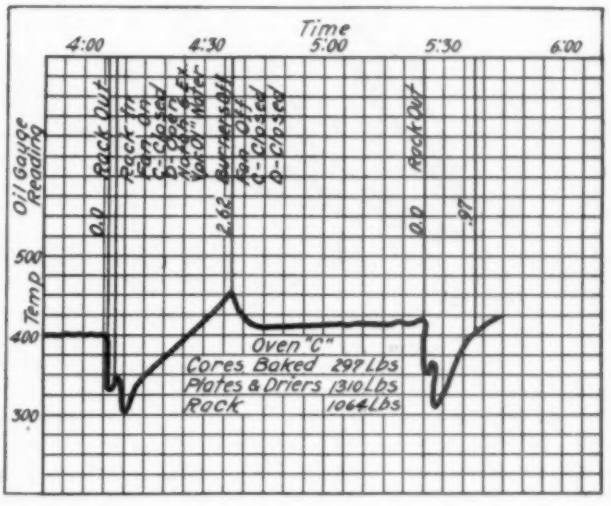


FIG. 17—RESULTS OF TESTS ON CORE BAKING IN OVEN "C"

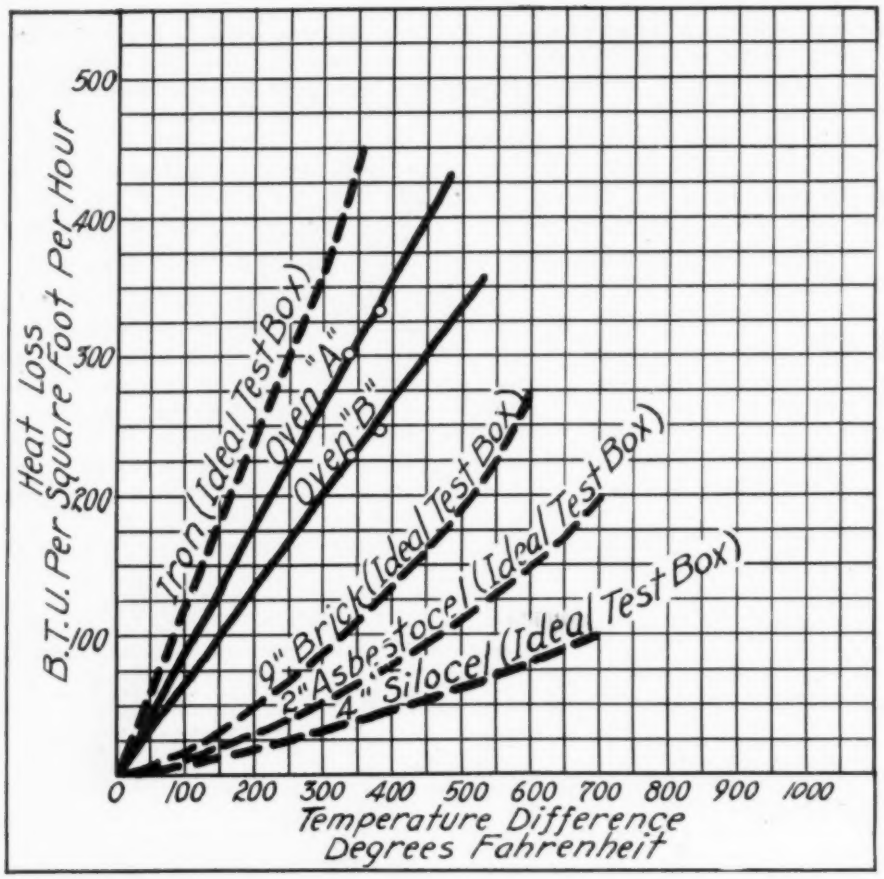


FIG. 18—COMPARISON OF IDEAL AND ACTUAL INSULATION

to 40 per cent of the total heat used for baking purposes was absorbed by this means of conveyance. This result depends directly on the type of oven used and the material baked. With a moment's thought it becomes evident at once that whatever heat is absorbed by any iron or metal conveyance must eventually become a total loss. Consequently, it is reasonable to believe that the conveyance whether rack, truck, plate or drier should be designed as light as possible and yet possess sufficient structural strength to resist warping and handling stresses. Naturally then, it is of utmost importance to exert every precaution not only to have a conveyance of correct design but to have the proper oven to do the work. Small work should be baked in ovens designed for small work, large cores in ovens designed for large work, etc. A rule to be applied here, then, might be set down in the following manner.

$$\text{Ratio} \frac{\text{Weight of cores}}{\text{Weight of metal or other conveyance}} = \text{maximum}$$

In other words the ratio of cores to be baked to the weight of shelves, racks, trucks, driers and plates should be balanced so as to obtain a maximum bake of cores for a minimum weight of conveyance. The result will be further effected by the length of bake. The longer the bake the less will be the loss of heat due to the removal of the nondesirable metal racks and other parts.

In connection with the preceding it might be interesting, to refer to a recent test made with electric ovens, at the plant of the Muncie Foundry Co.

	Muncie Test	Test Oven *A*
Weight of cores per bake pounds.....	1300 to 2900	324–382
Weight of truck pounds	1500	2000
Time of bake.....	3 to 7 hours	77 to 82 min.
Ratio cores to iron...	0.85 to 1.95	0.19
Result, pounds of cores per kilowatt	10.8	5.5

The preceding comparative examples are given to illustrate the effect of the weight of iron, cores and time on the resulting bake.

All losses reduce efficiency and increase cost. However, if the conditions presented are equal for all types of ovens the cost of operation becomes directly dependent on the price of fuel and maintenance. Maintainence cost is usually vague in comprehension owing to entering complications. Oil fuel burning requires the application of pumps, tanks, motors, etc.; likewise varying conditions and operating costs affect other fuels. The cost, or apparent cost, really is based on the fuel cost. This cost has been illustrated from actual observation. The B.t.u. heating value of the various mediums of heat is also customarily used as a basis for estimating heating costs, assuming a relative efficiency in each instance.

Lack of data on costs covering operation of ovens and all allied equipment, makes a hasty decision regarding the practicability of the electric oven an injustice. From observation, electric heat is entirely reliable, clean, and requires little attention. Its performance is pleasingly uniform. The operating costs are definite, undoubtedly the cost is its only important offense. From all present indications the possibilities of the electric oven depend principally on local fuel prices or the speculative nature of the foundryman.

Open Offices as Foundry Consultants

D. J. McAvoy and R. L. Binney have opened offices at 123 University avenue, Toledo, O., as general foundry consultants. Mr. McAvoy has held executive positions with various malleable, gray iron and nonferrous plants since 1909. Mr. Binney, who is a graduate of the University of Michigan 1912 has been metallurgist in turn for the Consolidated Manufacturing Co.; Edw. D. Savitsky, chief of the artillery equipment department of the Russian government before its downfall and in addition to local consulting work has served for the past four years as metallurgist of the Bunting Brass and Bronze Co., Toledo, O.

To Study Metallurgy

The department of metallurgy at Carnegie Institute of Technology, Pittsburgh, was recently selected by the United States Naval academy as its graduate school of metallurgy. Beginning this year, two officers from the Naval academy have been assigned to take up advanced work in metallurgical subjects at the Pittsburgh institution.

Small Cupola Operated Continuously 50 Hours

Question: What is the greatest amount of gray iron melted in a 24-inch cupola at one heat? How many hours was the cupola continuously in operation? Is it feasible to run a cupola of that size for 10 hours? Are pressure blowers essential on cupolas running long heats, or will the ordinary fan furnish sufficient air? What ratio of coke to iron melted has been obtained in cupolas operated under such conditions?

Answer: Operating a 24-inch cupola 10 hours a day, 6 days a week is regarded as ordinary practice in many shops, particularly in small converter plants. So far as we know, the following experience of Edgar A. Custer Jr., published in Vol. XX *Transactions*

of the American Foundrymen's Association constitutes a record for continuous melting in a small cupola. The iron was melted in a cupola lined to 21 inches and was poured into permanent molds, a branch of the industry in which Mr. Custer was actively interested at the time. The account says:

The run proper began at 7 a. m. Monday, Aug. 15, although at 5 a. m. the sand bottom was put in and the customary small quantity of wood lighted. The bed consisted of 140 pounds of coke and 70 pounds of anthracite coal. This brought the upper surface of the bed about 12 inches above the top tuyeres. The first charge was made up of 300 pounds of No. 2 pig and 300 pounds stove plate scrap and foundry remelt. The succeeding charges were made up of 35 pounds coke, 250 pounds pig iron and 250 pounds scrap. To this was added 15 pounds limestone. A blast pressure of 6 water ounces was maintained by a small rotary fan driven by motor and regulated by the usual blast gate.

At 7 a. m. the cupola was tapped out and on the twentieth charge it was found that the iron was coming too hot for our use. The iron charge then was raised to 600 pounds, the fuel to 50 pounds. At 7 a. m. Aug. 16, 64 charges had been melted, totalling 36,500 pounds, or about 1520 pounds per hour, at a ratio of 10 pounds of iron to 1 pound of fuel. The run was continued for 47½ hours and then it became necessary to drain the cupola and drop the bottom to repair the lining. This consumed 7½ hours and the cupola was started at once. The second run was almost identical with the first, except that the melting was rather sluggish for the first hour probably due to a damp lining. The second run ended on Aug. 19 at 2 p. m. a total of 49½ hours continuous running, during which 73,000 pounds of iron were melted at a ratio of 11 pounds of iron to 1 of fuel. As a grand total this cupola was operated for 97 hours out of 103 and melted a total of 144,800 pounds, or about 72 tons at a rate of approximately 3/4-ton per hour, at a fuel ratio of 11 to 1.

Should Cut Stock to Finished Size

BY M. E. DUGGAN

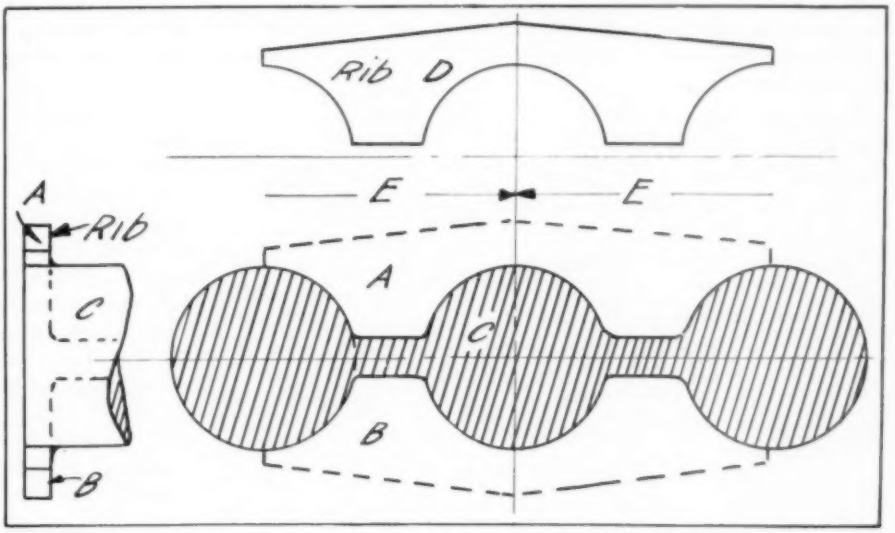
TOO many teachers, and for that matter too many patternmakers, seem to assume that a pattern should be constructed and finished after the fashion of a rare and beautiful piece of cabinet work and with that purpose in mind they insist on hand tooling it all over. Even in shops where power-driven tools are available and where the greater part of many patterns may be cut accurately to the dimension lines, they leave a generous margin for hand tooling. Recently I saw and heard a manual training teacher instructing his class in patternmaking how to make the pattern shown in the accompanying illustration. The particular lesson on this day dealt with how to cut and fit the ribs *D* on the body part *C*.

The boys were instructed to cut and dress the stock for the ribs, lay off the centers *E E*, describe the three circles, band saw *within* the lines, blue chalk the pattern where the ribs are to come into contact with it, then cut and fit the ribs. Part of these instructions were legitimate, but there is no excuse for the blue chalk and the cut-and-try method of fitting the ribs. The circles could be cut perfectly on the band saw and attached to the body of the pattern without any further fitting or waste of time. First impressions are lasting and a boy who has been taught that a band saw or other power tool is only to be used as a roughing medium will experience considerable difficulty in later years in adapting his mind to the fact that a great deal of hand tooling is unnecessary and that many patterns may be assembled direct from the band saw, the planer, or the rip saw.

In my own experience I have had more or less trouble in persuading young patternmakers to cut their stock to the finished size where it is practical to do so. There are limits to which any practice may be carried and the patternmaker must be guided by judgment and experience. When I was an apprentice 40 years ago patterns for gear wheels were made by hand and a patternmaker who could turn out a neat and accurate pattern was considered a first class mechanic. In many shops it was customary to have one or two men make all the gear patterns and in this manner these men became specialists. Mahogany, butternut, cherry and pine lumber were employed, the work, with the exception of the turning, was all done by hand and the finished pattern with a mirror-like surface, usually was a topic of admiration and discussion among the other patternmakers.

Conditions have changed to some extent in recent years, many gears now are cast as blanks and have the teeth cut in them afterward and many patterns in which the teeth formerly were slowly cut and formed by hand, now are cut directly to shape on the band saw. To keep up with the procession the young mechanic should become accustomed to using the power driven tools in the pattern shop.

In many instances the young mechanic lacks confidence. Fear of spoiling the piece impels him to *saw cut* away from the line and leave from ⅛ to ¼-inch to be hand tooled at the bench. This lack of confidence frequently is engendered by the unsatisfactory condition of the shop band saw. It is impossible to cut a piece exactly to the line or straight down on a dull saw, also, it is impossible to cut a short radius circle true to the line on a wide saw.



RIBS AND OTHER PARTS OF THIS CHARACTER CAN BE SHAPED ON THE BAND SAW

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Opportunities for Electric Furnace

IN EVERY field of the iron and steel industry into which the electric furnace has been introduced it has gained admission almost entirely on the plea of improved quality. Originally the electric furnace was advocated almost entirely for high grade alloy steels, or for refining open-hearth steel for uses where quality was of prime importance. Later the use of the electric furnace became quite broadly extended in the steel casting industry. The attraction here was the all-scrap mixture and its attendant low cost for raw materials. Pig iron is not essential for the manufacture of steel for casting purposes in the electric furnace and specifications are met by additions of a small percentage of ferroalloys. In the gray-iron field the electric furnace is following much the same course as in the steel industry. A few firms are operating the electric furnace for making special work, such as piston-ring castings where the tonnage of metal is comparatively low when compared to the price received or the product into which it enters. The electric furnace also is used to a limited extent in the foundry to refine iron melted in the cupola. However, these two uses will never bring the electric furnace into general popularity in the gray-iron foundry. If it is to be generally applied in this industry other incentives must be advanced. At present one application of the electric furnace is being made which has possibilities for future extension, namely for melting scrap. Large industrial works produce a great volume of turnings, both steel and cast iron for which they can get little return. On the other hand they must pay a much higher price for pig iron to melt in their cupolas. Naturally, these firms have a decided advantage in operating an electric furnace for making gray-iron castings over those which do not have turnings to dispose of and this offers one of the most promising fields for the electric furnace in the gray-iron foundry. This is especially true as electric furnaces can be operated as small units, those of a half-ton capacity, or even smaller, having been successfully used. That both steel and gray iron can be used in the electric furnace has been demonstrated, heats having been made from all-steel charges as well as from charges consisting entirely of gray-iron turnings. Of course, additions of silicon and manganese must be made to charges consisting entirely of steel scrap, but the expense of these is not excessive in the small amounts required. This field has been extensively developed abroad as indicated by a report of the United States consular service which says that 14 electric furnace plants are in operation in Italy making gray-iron synthetically. In that country the scarcity of coal and the highly developed water power systems add an incentive to the production of synthetic cast iron. Cheap power might be obtained in this country if foundries would melt at night during the off load of power plants, using the metal to pour molds made in the day time. Possibly such a course might not be feasible for the large foundry but it certainly does look inviting for the large manufacturer who has quantities of turnings to dispose of and also has a demand for prompt production of certain castings. One company which established an electric steel foundry years ago to furnish itself promptly with special castings without regard for cost, later found that it could produce from the electric furnace many of its castings cheaper than it could purchase them from foundries using the open-hearth or the converter.

Trade Outlook in the Foundry Industry

TRANSPORTATION difficulties continue to bear the burden of blame for most of the industrial ills, including the slight decrease in foundry activity noted during the month of October. The week ending Oct. 7 shows a daily average shortage of 141,252 cars and a surplus of 3954; while at the beginning of the present year, the daily average surplus was 400,000 cars. The effect is apparent in the movement both of raw materials and finished products, and a drop in car loadings is showing the results of the shortage of cars and the embargoes existing. Although these two factors are serving to hinder shipments and in some cases to delay orders, business has held up well during the month.

Prices Slackening

The steadiness with which the price of coke is declining leads some to expect a price of $6 to $7 ovens for the beehive product before many weeks. With few exceptions, the by-product manufacturers have not reduced their prices on foundry grades. Shipments of coke are satisfactory, according to reports sent from foundries in the Central States. Pig iron prices are receding slowly as production picks up. Some interest is expressed in iron for delivery during the first quarter of 1923 and something over 2000 tons of foundry iron is reported booked by Pennsylvania and Buffalo furnaces for shipment into New England. Purchases of foundry materials have not been heavy during the latter part of September and the entire month of October. This fact is shown vividly in a chart prepared by the Ohio State Foundrymen's association and presented at the bottom of this page. It will be noted that the actual melt during September decreased to 63 per cent, the previous month having shown about 72 per cent. Furthermore, the total stock on hand shows a loss, while the stock received has taken a sharp drop. The graphs are compiled from information submitted by 68 foundries whose normal melt is 21,761 tons. That the condition in Ohio is representative of the Central Western states is affirmed by isolated reports throughout this territory. One considerable factor in the situation is the drop in automobile production. According to the department of commerce, the total output for September was 186,562 passenger cars and 18,843 trucks, as compared to 249,225 passenger cars and 24,200 trucks for August. The September output was the lowest since March, this year. However, the sales of closed cars and the introduction of a few changes in design helped considerably to sustain manufacturing activity for October.

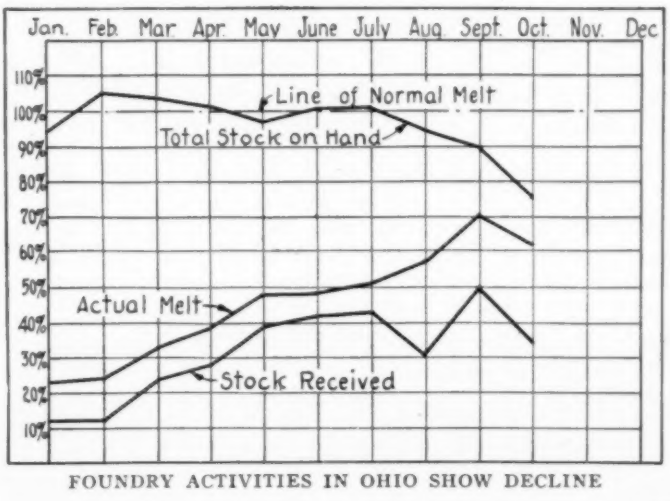
Prices of Raw Material for Foundry Use

CORRECTED TO OCT. 25

Iron		Scrap	
No. 2 Foundry, Valley	$30.00 to 32.00	Heavy melting steel, Valley	$21.00 to 21.50
No. 2 Southern, Birmingham	27.00 to 30.00	Heavy melting steel, Pitts...	21.00 to 21.50
No. 2 Foundry, Chicago	31.00 to 32.00	Heavy melting steel, Chicago	18.00 to 18.50
No. 2 Foundry, Philadelphia	31.13 to 31.64	Stove plate, Chicago	19.50 to 20.00
No. 2 Foundry, Buffalo	29.50 to 32.00	No. 1 machy. cast, Chicago	23.50 to 24.00
Basic, Valley	30.00	No. 1 cast, Philadelphia	23.00 to 25.00
Basic, Buffalo	30.00 to 31.00	No. 1 cast, Birmingham	21.00 to 23.00
Malleable, Chicago	31.00 to 32.00	No. 1 cast, Buffalo	21.00 to 22.00
Malleable, Buffalo	31.00 to 32.00	Car wheels, iron, Pittsburgh	23.50 to 24.00
Coke		Car wheels, iron, Chicago	25.00 to 25.50
Connellsville foundry, coke	$10.00 to 11.00	Railroad malleable, Chicago	24.00 to 24.50
Wise county foundry, coke	12.00 to 13.00	Agricultural mal., Chicago	24.50 to 25.00
		Malleable, Buffalo	20.50 to 21.50

Rail Buying Sustained

Railroad purchases continue to furnish an active market for castings. In September, orders were placed for 10,350 cars, as compared with about 1600 during the previous month, when a temporary lull was apparent. Inquiry for railroad cars is active and sales during the first three weeks of October have been large with the expectation of a still greater volume of orders before the end of the year. Although the production of malleable castings is slightly curtailed during the month of October, railway specialty shops are working at capacity. The locomotive steel foundries are working at 100 per cent and new orders and inquiries for locomotives are appearing almost daily. Foreign sales of railway equipment are increasing. The American Steel Foundries has taken a contract for 33,000 couplers for railway use in Japan, to be completed and ready for shipment before Jan. 1. A seasonal decline in building construction is noted, although the past month showed a higher total of contracts awarded than September, 1921. However, orders for sanitary ware castings were sustained. Sales of agricultural implements and tractors vary in different localities. In the South, where the cotton crop is practically all marketed, buying is active. In the corn belt, sales are improving slightly with the increased price of farm products. Export sales of implements are increasing and foundries making this class of castings are busy.



FOUNDRY ACTIVITIES IN OHIO SHOW DECLINE

Nonferrous Active

Brass and aluminum foundries are engaged at between 65 and 70 per cent of normal. Plumbing goods are in fair demand and miscellaneous castings for automotive lines are sustaining the averages noted. Prices on nonferrous castings based on New York quotations in *The Daily Metal Trade* of Oct. 25, follow: Casting copper, 13.40c to 13.50c; electrolytic copper, 13.87½c to 14.00c; Straits tin, 36.00c; lead, 6.75c to 6.87½c; antimony, 6.75c; aluminum, No. 12 alloy, producers' price, 21.00c to 21.20c and open market, 19.00c. Zinc is 7.05c, E. St. Louis, Ill.

Comings and Goings of Foundrymen

SAMUEL Wesley Stratton, organizer and for 21 years director of the bureau of standards, Washington, has resigned to become president of the Massachusetts Institute of Technology, Jan. 1, 1923. Dr. Stratton, whose resignation is described by Secretary Hoover as "a real national loss," is not new to the educational field. From 1886 to 1891, when he organized the bureau of standards for the government, Dr. Stratton taught mathematics, physics and electrical engineering at the University of Illinois and the University of Chicago in various capacities, as instructor, assistant professor, associate professor, and professor. He was graduated from the University of Illinois in 1884. Since then he has received degrees of doctor of engineering and doctor of science from several universities, including the University of Pittsburgh, Cambridge and Yale. He was born in Litchfield, Ill., July 18, 1861. Dr. Stratton, who was an officer in the Illinois naval militia, served as a lieutenant in the navy during the Spanish-American war and later was in charge of the District of Columbia naval militia. Dr. Stratton is a member of many technical societies. He has been awarded the Elliot Cresson medal by the Franklin institute and the Public Welfare medal by the National Academy of Sciences and is a chevalier of the Legion of Honor.

Charles Hans has accepted a position as foundry foreman with the Chambers Manufacturing Co., Shelbyville, Ind.

S. W. Burrows has accepted the position of foreman of the foundry of the Chicago & Great Western railroad, Oelwein, Iowa.

Herman Hedthke recently has been made foundry superintendent of Pettibone, Mulliken Co., Chicago, Ill., who operate a steel foundry, producing railroad equipment castings.

Henry M. Griffoul has resigned as brass foundry foreman of the Ideal Foundry & Machine Co., Beaver Falls, Pa., to accept a position with the John Harsch Brass & Bronze Co., Cleveland.

Charles La Fever has accepted the position of vice president and works manager of the James A. Brady Foundry Co., formerly the largest jobbing foundry in Chicago. Tom Cameron of Buffalo, has been made superintendent.

J. P. Hansen, formerly with the Canadian Car & Foundry Co., has been made manager of Roos Foundries, Chicago, succeeding M. D. Brown, resigned.

F. C. Knight for ten years salesman with the New England Coal & Coke Co., Boston, has joined the sales organization of Alley & Page with headquarters at 185 Devonshire St., Boston.

Walter S. McKee has resigned as vice president and director of the

SAMUEL WESLEY STRATTON

American Manganese Steel Co. and will develop the business of the Inland Engineering Co. of Chicago, of which he is president.

Fred M. Devlin, president of the Philadelphia Hardware & Malleable Iron Co., Philadelphia, has been appointed president of the Philadelphia Foundrymen's association to fill the unexpired term of his father, Thomas Devlin, who died last June.

Foundrymen on Steel Committee

Under the chairmanship of H. M. Boylston, Case School of Applied Science, Cleveland, committee *A*-4 on the heat treatment of iron and steel of the American Society for Testing Materials, held a meeting during the convention of the American Society for Steel Treating at Detroit, Oct. 2-6. It was announced that the American Foundrymen's association has been given representation on that committee, the representative selected by the foundrymen being H. A. Neel, Michigan Steel Castings Co., Detroit. It was announced also that a new subcommittee on nomenclature to be known as subcommittee 6 has been formed with Dr. G. B. Waterhouse, professor of metallurgy, Massachusetts Institute of Technology, as chairman. E. W. Ehn, Timken Roller Bearing Co., Canton, O., was elected the new chairman of the subcommittee on case hardened objects. The work of a subcommittee on heat treatment of wrought iron has been attracting considerable interest.

Addresses New England Foundrymen

The problem of moving material in an industrial plant was the subject of a paper presented by H. P. Blumenauer, Arcade Malleable Iron Co., Worcester, Oct. 11, before the New England Foundrymen's association. The speaker said the complete analysis of any existing problem was the first essential to its correct solution. In the handling of material it is important to have all factors considered in an impartial light before expensive labor saving equipment is purchased. If the plant organization is not planned, the best equipment is apt to prove faulty. Therefore, it is important to have superintendents and foremen, and others responsible in favor of whatever handling schemes are to be adopted. The paper was illustrated with lantern slides of material handling operations in this country, and India.

New Society Has a Large Attendance

The second meeting of the Quad City Foundrymen's association held in Rock Island Oct. 16 was addressed by Richard Moldenke who gave an interesting talk on general foundry practice and answered many questions from those in the audience. The interest shown in the new organization is indicated by the fact that 90 foundryman from 27 gray-iron, malleable, steel, brass and aluminum shops, representing all departments, were in attendance. It was decided to hold regular meetings on the third Monday of each month.

Equipment Buying More Active

Broad Market for Foundry Equipment Noted, Especially for Molding Machines—Inquiries Numerous for Sand Handling Equipment, but Sales Are Not Large

ENCOURAGEMENT is seen by the equipment manufacturers in a broad market during the past month for practically all classes of foundry equipment. Sales of sand handling equipment have not been as active as sales in other branches of the equipment field, but numerous inquiries for good sized installations have been received which will probably turn into orders shortly. The Osborn Mfg. Co., Cleveland, has sold a number of molding machines including an electric rollover jolt machine with flask filling equipment to an English firm. A large rollover jolt machine was sold to an eastern manufacturer and several of the same type machines were ordered by New England firms. The Northern Engineering Works, Detroit, has sold a number of cranes, one 2-motor, 5-ton crane going to the Vulcan Iron Works, Winnipeg, Can. A battery of 11 core ovens with a complement of heavy-duty cars and racks was sold to the Frick Co., Waynesboro, Pa., by the Foundry Equipment Co., Cleveland. This company also sold a second installation of core ovens to the H. Mueller Mfg. Co., Decatur, Ill.

Steel Foundries Active in Pittsburgh District

WHILE iron foundries in the Pittsburgh district are not overly active, steel foundry operations are maintained at a high rate. Inquiries for foundry equipment continue numerous, particularly for molding machines, and the Zelienople, Pa., molding machine manufacturer is receiving them practically by every mail. The company is operating upon a 100 per cent basis although recent orders have not been so numerous as was expected. However, since four or five of the sizes it produces are well standardized, it is possible to build these for stock. The Tennessee Coal, Iron & Railroad Co. has an inquiry out for about 20 molding machines, and while this number probably may be reduced, large machines will be purchased. The American Locomotive Co. also has an inquiry out for a large number of molding machines and numerous other foundry interests have inquired for one to five each. Within the next week or two some sizable business is expected to be closed since the verbal orders now are in hand. A Williamsport, Pa., interest has just ordered a large core oven. A foundry at Yukon, Pa., which recently bought a cupola, likewise closed upon ladles, sand sifters, sand mixers, blower, and a complete line of facings and supplies with a large foundry equipment seller located in Pittsburgh. Various sales of tumbling barrels, sand mixers, emery grinders, etc., are noted. Recent purchasers of sand mixers include the Bessemer Gas Engine Co., Grove City, Pa., and the E. W. Bliss Co., Salem, O. Orders for steel flasks have been placed in fairly large numbers recently with the Sterling Wheelbarrow Co., involving up to 100 flasks at a time, the Carnegie Steel Co. and the Westinghouse Electric & Mfg. Co. being among recent purchasers. A nearby steel foundry is in the market for eight shop cars, while the Pittsburgh Gray Iron Foundry Co. recently bought two for iron hauling, etc. Foundries operating machine shops enter the market for machine tool equipment from time to time, recent inquiries involving single lathes, milling machines, grinding machines, etc. One or two cupola propositions still are being worked upon as are several crane and hoist inquiries. The Mackintosh-Hemphill Co. is in the market for cranes, including one for the A. Garrison Foundry Co. The Patterson Foundry & Machine Co., East Liverpool, O., closed upon a 5-ton electric jib crane with Alfred Box & Co., Philadelphia. The Pittsburgh Knife & Forge Co., Coraopolis, Pa., still is in the market for a 10-ton crane, and the Universal Steel Co., Bridgeville, Pa., wants similar equipment.

Chicago Reports Broad Demand

GOOD demand for foundry equipment is being received from all sections of the country, the western field coming forward with much more business than formerly, keeping up with activities in the East. While much of the equipment now being bought is small, there is sufficient of the heavier type to keep manufacturers fairly busy, and plants turning out cranes, ladles, molding machines and other types for foundry use have increased their percentage of production materially. Proper preparation of sand is coming to the front strongly in the foundry industries, and the National Engineering Co. is making steady sales of various sizes of mixers. This interest finds inquiries are well scattered over the country, indicating a general increase in foundry operation. The new foundry of the Pullman Co., at Pullman, Ill., is being erected and placing of equipment will be started in December. The Duroth Steel Truck & Car Wheel Co., Philadelphia, has purchased a 45-inch cupola, a 24 x 60-inch tumbling barrel and three 4000-pound helical geared ladles from the Whiting Corp. The Eastern Foundry Co., Boyertown, Pa., has ordered a 66-inch cupola from the same interest and the Kewanee Boiler Co. has placed a 36 x 54-inch water cinder mill with the Whiting Corp.

No Big Orders in New York District

DESPITE the rising tendency of equipment prices, few changes have been noted in foundry supplies and the market in this district is inclined to sluggishness. The railroads, notwithstanding expectations to the contrary, up to the present have not made purchases of consequence in the eastern district. At the same time, some new projects in this district under contemplation are developing slowly. Such buying as is now transacted involves principally orders for single machines and supplies, such as flasks, etc. The American Radiator Co. has been a recent buyer, closing on two sand cutters for its Buffalo plant. The General Fire Extinguisher Co., Providence, R. I., bought two 5-ton traveling cranes from the Northern Engineering Works, Detroit, for installation, it is understood, in one of its foundries. Among new projects are a foundry addition for the Blakeslee Forging Co., Plantsville, Conn., a foundry building for the Bartlett Hayward Co., Baltimore, and a foundry addition for the Southern Machinery Co., Quitman, Ga. The Pierce, Butler & Pierce Mfg. Corp., Syracuse, N. Y., is contemplating extensions, said to include a foundry addition, as is also the Rabe Pipe & Foundry Co., Chattanooga, Tenn.

What the Foundries Are Doing

Activities of the Gray Iron, Malleable, Steel and Brass Shops

The Western Stove Co., Oakland, Cal., contemplates establishing a plant at Pomona, Cal.

The Manganese Foundry, Ltd., Sherbrooke, Que., is opening a plant at Sherbrooke.

The Rabe Pipe & Foundry Co., Chattanooga, Tenn., is having plans prepared for the erection of a plant addition, 100 x 150 feet.

The American Brake Shoe & Foundry Co., New York, is reported planning to establish a branch plant at Houston, Tex.

R. E. Campbell, 1000 Taylor street, Columbia, S. C., plans to establish a plant for the manufacture of stoves, etc.

The Buckeye Casting Co., Lima, O., plans the erection of two foundry buildings at an estimated cost of $75,000.

The Federal Steel Foundry Co., Chester, Pa., recently announced it will reopen its foundry for the production of steel castings.

The Mobile Pulley & Machine Works, Mobile, Ala., is reported preparing plans for the installation of a steelmaking unit at its plant.

The National Cast Iron Pipe Co., Tarrant City, Ala., plans to enlarge and remodel its plant.

The Hillman-Ayers Mfg. Co., Kansas City, Mo., machine tools, recently was incorporated by W. B. Laughlin, J. P. and A. A. Hillman.

Contract has been let by the Belknap Mfg. Co., Bridgeport, Conn., for the erection of a 2-story foundry addition, 25 x 60 feet.

The plant of the Illinois Foundry & Machine Co., Belleville, Ill., recently was damaged by fire.

The Bartlett Hayward Co., Baltimore, plans the erection of a 1-story foundry building, 202 x 262 feet.

The Monroe Brass & Wire Co., Cincinnati, recently was incorporated by G. F. Monroe, Oliver S. Bryant and G. Jolly.

The Binghamton Foundry & Machine Co., Inc., Binghamton, N. Y., recently was incorporated with a capital stock of $250,000 by R. S. Cooper and others.

The Seaboard Foundries, Inc., Brooklyn, N. Y., recently was incorporated with a capital stock of $110,000 by Hubert W. Eldred, 105 Fourth street, Ridfield, N. J., and others.

Equipped for making castings in bronze, brass or aluminum in any size, the Phoenix Brass Foundry, Irvington, N. J., recently completed the erection of its new plant.

The Hydro Pop Valve Co., Akron, O., recently was incorporated with $25,000 capital stock by Thomas Frankland, George J. McCracken, Melvin E. Dixon and C. G. Roetzel.

An addition will be made to the foundry and machine shops of the Southern Machinery Co., Quitman, Ga., which will double the present capacity of the plant.

Capitalized at $100,000 the Seaboard Brass & Copper Co., Baltimore, recently was organized by B. H. Rollin, H. F. Bennett and C. W. Smith.

Capitalized at $50,000 the National Bronze Co., Ltd., Montreal, Que., recently was incorporated by Henry N. Chanvin, John J. Meagher and Harold E. Walker.

The Dodds Canadian Iron Works, Ltd., Welland, Ont., has been incorporated with $200,000 capital stock to manufacture flour mill machinery, etc.

The Fleck-Marshall Co., Lancaster, Pa., manufacturer of plumbing supplies, has purchased the Rothfuss-Howard Iron Works, Williamsport, Pa., and will make alterations.

The Brass Foundry Corp., New York, recently was incorporated with a capital stock of $15,000 by L. Stein, J. Schlachier and J. Safer. The company is represented by W. Karlin, 162 Nassau street, New York.

The Robertshaw Co., Youngwood, Pa., manufacturer of pipe fittings, etc., plans the erection of a machine shop and foundry, each one story, 110 x 130 feet and 30 x 65 feet, respectively.

Capitalized at $10,000 the Janesville Refrigerator & Pump Co., Janesville, Wis., recently was incorporated by S. V. Corona, M. E. Douglas and Dan H. Peterson, to manufacture refrigerating units, pumps, etc.

Capitalized at $50,000 the Protect Your Home Lock Co., 309 South La Salle street, Chicago, recently was incorporated to deal in merchandise, operate a foundry, etc., by Joseph C. Wolon, E. M. Wolon, Max B. Ginsberg, Charles McCabe and others.

With $25,000 capital stock the General Die Casting & Machine Co., 2535 North Ashland avenue, Chicago, recently was incorporated by E. C. Tourie, William F. Waugh, Walter F. Olds, W. A. Kelly and M. M. Scenigerath. The company is represented by Olds & Tourie, Marquette building, Chicago.

Capitalized at $5000 the Cragin Pattern & Castings Co., 4916-28 Bloomingdale avenue, Chicago, recently was incorporated by George W. Swain, Harold D. Burgess and E. B. Pierce. The company is represented by Scott, Bancroft, Martin & MacLeish, 134 South La Salle street, Chicago.

Improvements now are being made at the plant of the Advance Foundry Co., Dayton, O. These will enlarge the coremaking and molding departments, buildings as well as new equipment being provided for both departments. These additions are necessities for the company to meet the demand for its goods.

The Fellows Brass & Iron Foundry, Auburn, Me., will move within a few weeks to Waterville, Me., where it will remodel and occupy the old Lombard Foundry plant which has been idle for five or six years. Lloyd McFadden, of Auburn, will start a foundry in the building vacated by the Fellows Brass & Iron Foundry.

Architect Brust & Philipp, 405 Broadway, Milwaukee, have completed plans for the Kohler Co., Kohler, Wis., for the erection of a new mill building, four stories, 75 x 160 feet, to be equipped for the preparation of enameling materials. The company manufactures bathtubs and other sanitary goods, as well as farm lighting plants. It also is one of the largest makers of enameled sanitary ware in the United States.

At the annual election of the Pacific Car & Foundry Co., held recently, John Twohy, of Spokane, was re-elected president. Other officers named were: O. D. Colvin, vice president; H. N. Curd, vice president and general manager, and W. S Bassage, secretary. The board of directors includes William Pigott, John Twohy, T. S. Clingan, O. D. Colvin, James F. Twohy, H. N. Curd, F. W. Chriswell, E. M. Wilson and D. E. McLoughlin, the latter two being interested in San Francisco headquarters of the Pacific Coast Steel Co. The Pacific Car & Foundry Co. operates a car building plant at Renton, Wash., near Seattle.

Merger of the American Carbonic Machinery Co. and the Grand Rapids Foundry Co., under the name of the former recently was announced by O. R. Roenius, general manager. The two companies have been owned and controlled by the same interests for some time but as the product of the foundry company has been mostly refrigerating machinery and as the sales and engineering organization's name more properly identified the business the consolidation was made. The company is located at Wisconsin Rapids, Wis., which formerly was known as Grand Rapids, Wis. Its capitalization now is $200,000. Ownership of the company largely is in the hands of E. Roenius, O. R. Roenius, Fred A. Roenius and Oscar E. Uehling.

New Trade Publications

STEEL WINDOWS—David Lupton's Sons Co., Allegheny avenue and Agate street, Philadelphia, has issued a new illustrated catalog on steel windows. The first section describes the various types of windows for use in apartments and residences. The second section shows the use of the projected sash, in at top or out at bottom, in offices, public buildings, etc. The third section describes and illustrates the counterbalanced sash as it is used in schools, manufacturing plants, etc. The fourth section takes up in detail the various types and uses of the pivoted sash. The operating device used in connection with this sash is also included in this section. The fifth section includes descriptions and illustrations of the Pond continuous sash and the Pond operating device. The last pages illustrate and describe pressed steel door frames, rolled steel sky light, corrugated wire glass, steel shelving, unit shelving and miscellaneous factory equipment.

GRAPHIC INSTRUMENTS — Automatic control signalling and alarm instruments are described and illustrated in a 24-page illustrated booklet recently published by the Brown Instrument Co., Philadelphia. The equipment includes a tomatic control pyrometers as installed on electric furnaces, gas fired and oil fired furnaces; indicating control thermometers; recording control thermometers; indicating and recording pyrometers; signalling instruments and control switches and panels for electrically heated devices. In addition automatic control valves are described.

PULLEYS—McMahon & Co., Worcester, Mass., are circulating an illustrated folder in which patent friction pulleys, friction cut-off couplings and friction clutches are described and illustrated.